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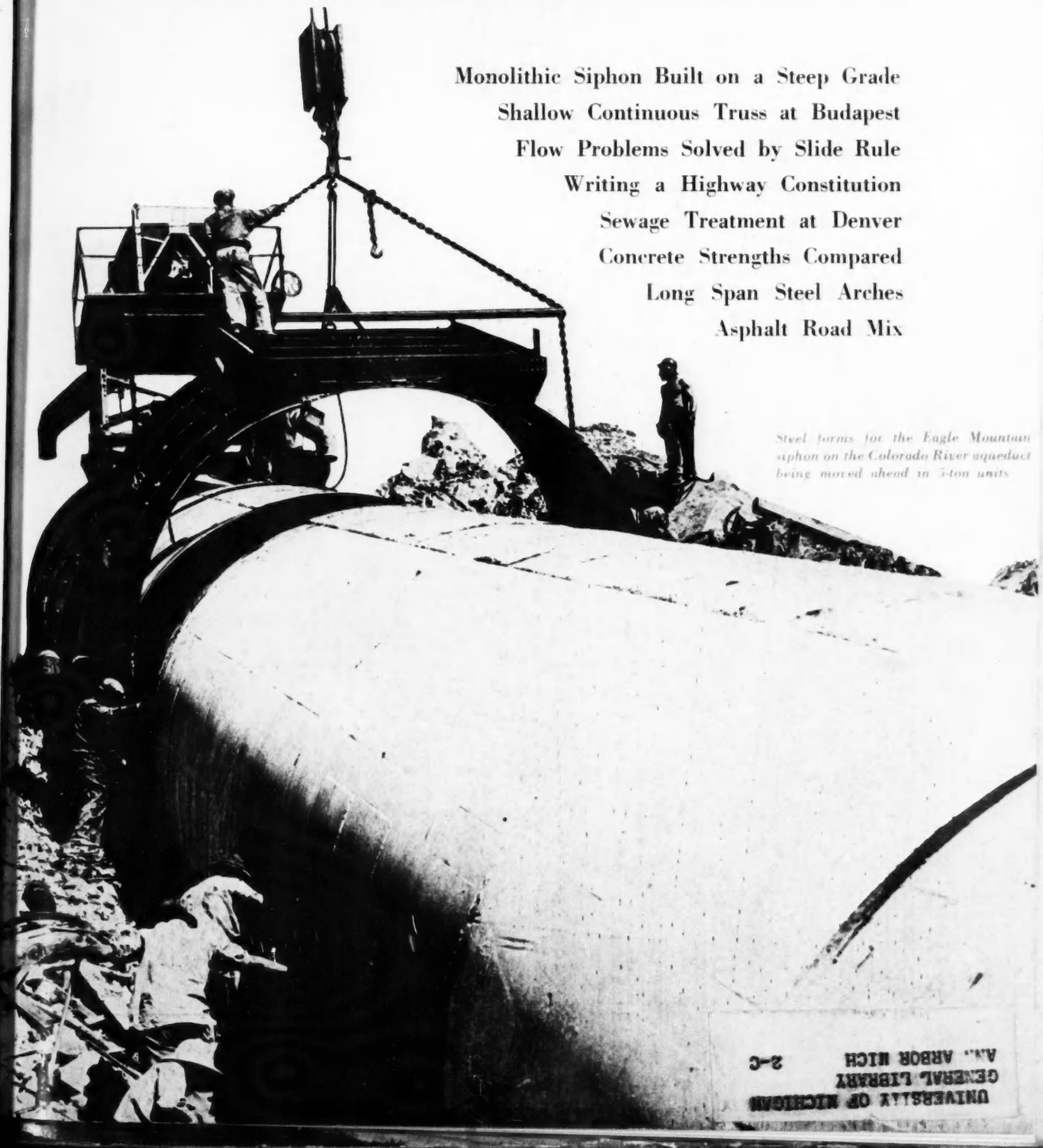

Steel forms for the Eagle Mountain siphon on the Colorado River aqueduct being moved ahead in 5-ton units

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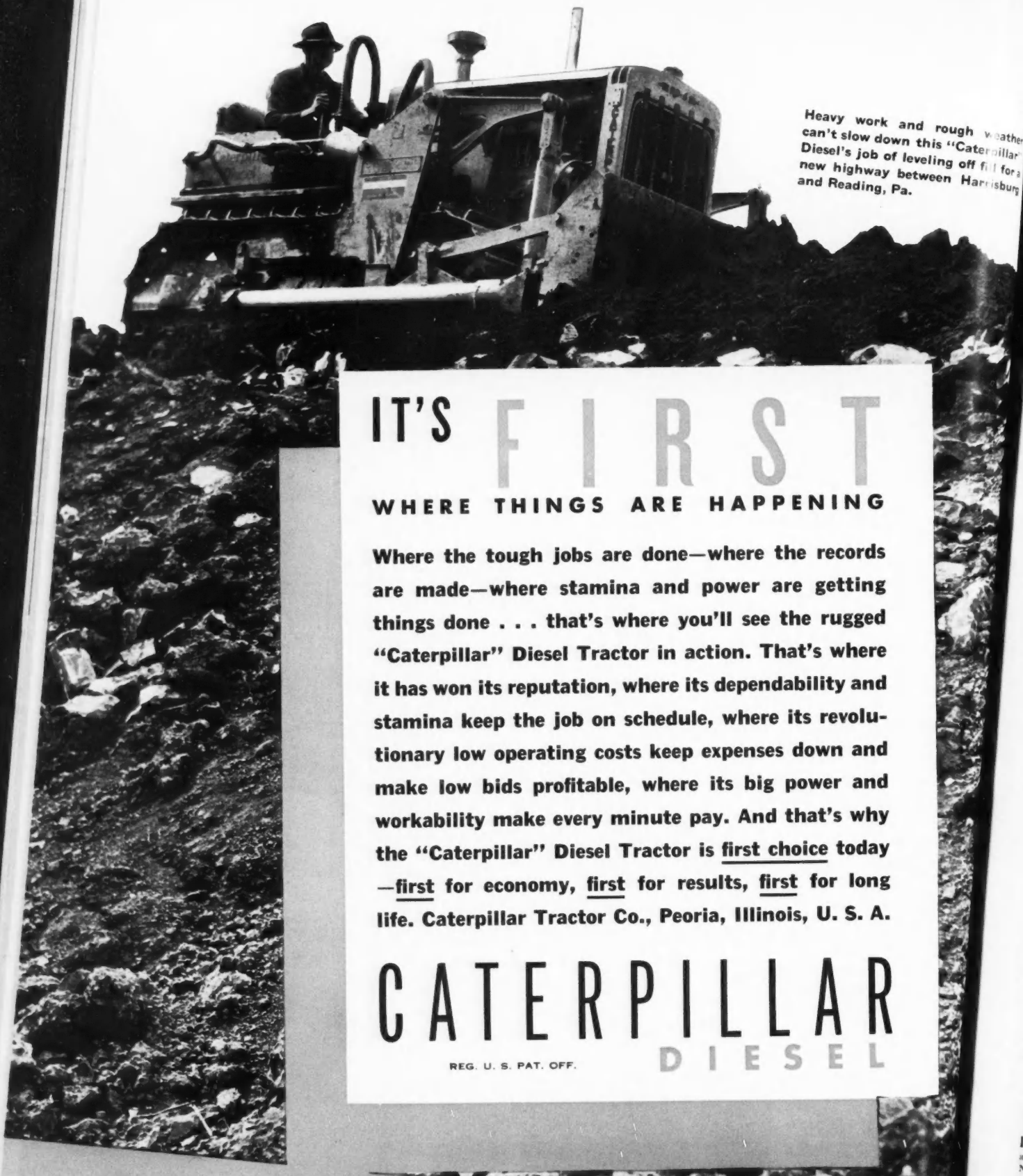

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SALVATION *through* STARVATION

IN HIS recent address before the Denver session of the American Mining Congress, former President Hoover laid down some truetalk about taxes that will appeal to every thoughtful person who understands the problems of modern industry. From time to time this page has maintained that the effect of taxation on productive enterprise is less a matter of amount than it is of method. Mr. Hoover has set forth clearly just why this is true. What he said should be read and pondered by every legislator whose vote may contribute toward any measure of taxation.

In discussing the recently enacted corporation tax law he shows why certain of its provisions are so unfortunate as to justify the admission, even by New Deal champions, that they are destructive blunders. He shows, for example, how the tax on undistributed profits will tend to obstruct technical progress, stifle honest enterprise, discourage industrial employment, throttle competition and put a premium on imprudent financing.

The objective of those who fathered this provision of the tax bill was twofold. It was intended to checkmate the practice of evading incomes taxes by letting earnings accumulate as surplus rather than pay them out as dividends. It was intended also to direct more of the national income into current consumption and thereby prevent the undue expansion of productive facilities.

THE first of these is calculated to correct an abuse in current taxation practice; the other is designed to effect an economic reform. As so often happens with such two-edged measures, this one creates evils worse than those it is intended to correct.

In trying to prevent tax evasion it deprives industry of the resources it needs to conserve its productive plant; it dissipates the reasonable cushion that every business as well as every individual needs for safety and stability; it drives the managers of industry from conservative financing out of earnings into borrowing that means higher fixed charges and less flexible expense structures. All this Mr. Hoover has shown plainly and in detail.

He did not point out, however, that the secondary objective of those who wrote this tax bill, i.e., that of directing corporate income into consumer rather than capital expenditure, is based on a fallacy. It assumes that our productive plant actually is overbuilt in periods of expansion such as that of the twenties and that it is necessary for government, through its taxing power, to curb such construction by preempting the available funds.

During the early stages of the depression this view was widely held. But today it has been fairly well demonstrated that the collapse of the twenties was not chargeable to the physical expansion of our productive plant; it was the result of expanding the structure of paper values all out of proportion to the expansion of productive facilities. Our trouble was not that we built too many plants or increased unduly our capacity to produce useful things; it was that we tried to get rich quick by excessive speculation in fictitious paper claims issued against our productive plant.

SO IT is a mistake for us to penalize the use of earnings for legitimate capital purposes on the assumption that we suffer from excess productive capacity. When we do that we are barking up the wrong tree.

Mr. Hoover sets forth clearly the legitimate and necessary uses of surplus: to expand and improve productive facilities; to replace obsolete plant; to provide a cushion against evil days; to avoid undue expansion of the industrial debt structure with its inflexible overhead burden. With such essential functions provided for, stockholders are entitled to the remainder of their earnings as dividends. Perversion of surpluses into a device for tax evasion or to feed stock market speculation are evils that may well be attacked and curbed through federal taxation if that can be done without injury to legitimate enterprise.

But it does not make sense to penalize prudence and to starve industry to death in order to keep it from wasting its substance in speculation or from dodging its tax obligations.

Willard Chevalier

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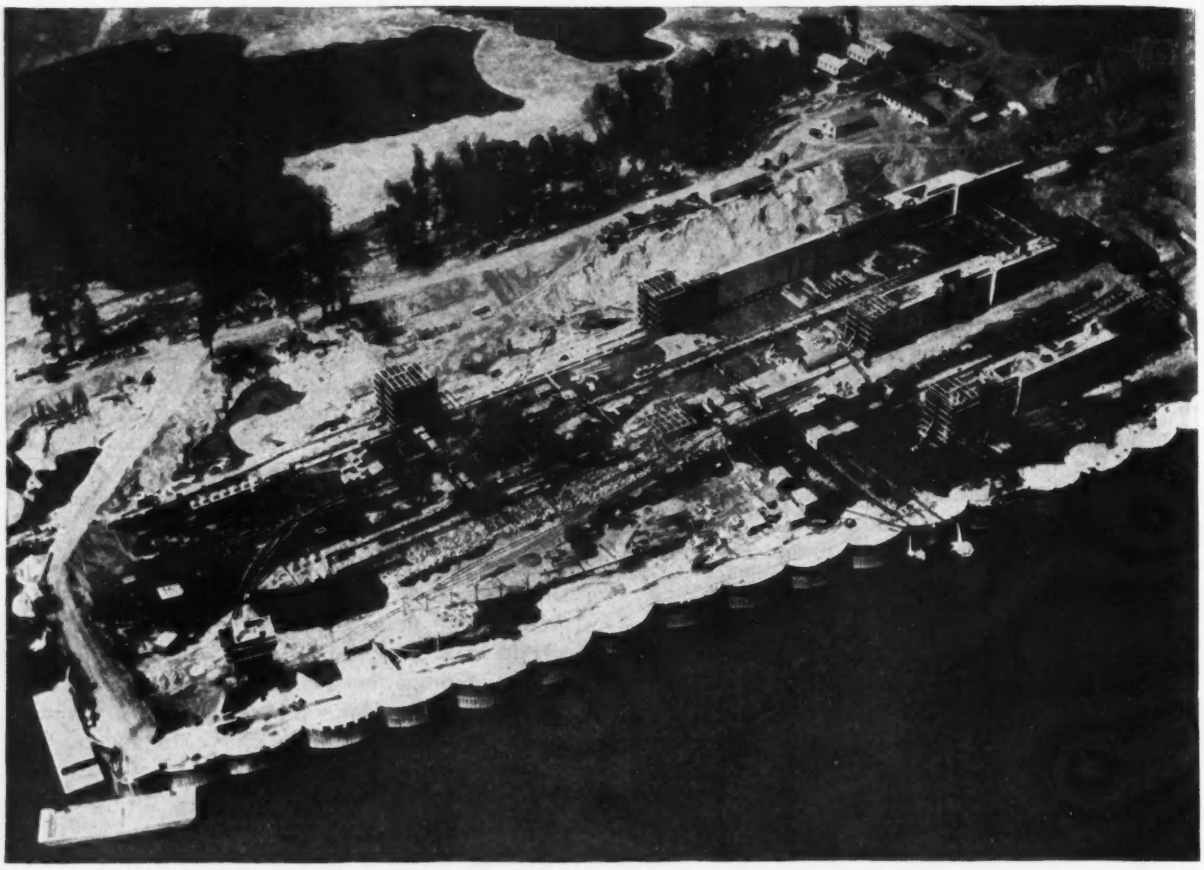

Inland Piling at Lock 25 On The Mississippi

Above: Construction photo of Mississippi Lock No. 25 at Cap Au Gris, Missouri. 1751 tons of Inland Section I-23 was used, some of the piles being 65 feet long.

This is the latest aerial photograph of the construction work underway on Lock No. 25 at Cap Au Gris on the Mississippi River.

The view clearly shows the neat tight job of Inland Steel Sheet Piling installed by the United Construction Co. United reports everything going well and work progressing splendidly.

This is but one of many successful Inland Piling jobs on the Mississippi. But Piling is only a part of the picture, for Inland Engineers work closely with the contractors from beginning to end, co-operating on design, method and construction until the job is completed.

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■

Out of the Ash Heap — New York is at last finding use for the great heaps of refuse that have been hauled out of Brooklyn and Queens for years past. Next Week's issue will tell how shovels and trucks, working 24 hours a day, are cutting down the ash heaps to make fill for the New York World's Fair. It is a high-speed job done against time.

Strong – Attractive Culverts

AT LOWER CONSTRUCTION COSTS

YOU will be wise to investigate the economy and ease of handling of USS American Sectional Plates, for small bridges, all types of sewers, for enclosing small streams, for conduits, for safety underpasses, for replacement of unsafe or damaged structures, and a wide range of similar uses.*

These sectional plates provide a number of advantages over other types of construction. They are easy to ship and prompt deliveries can be made. They are simple to erect; they can be assembled quickly and easily because they are so accurately formed and punched in manufacture that the most inexpensive labor can join them together with ease. Another time and labor saving feature is that this type of structure requires no forms and rarely requires shoring.

USS Sectional Plates have a heavy galvanized coating which gives them longer life and is an added protection against corrosion.

The simplicity in the erection of USS American Sectional Plates not only reduces labor costs, but also cuts down annoying traffic tie-ups and detours. This type of structure costs less to erect, yet has all of the features necessary to produce strength, attractiveness and durability.

We will be glad to furnish you with further information and added details on how USS American Sectional Plates can do a better job for you.

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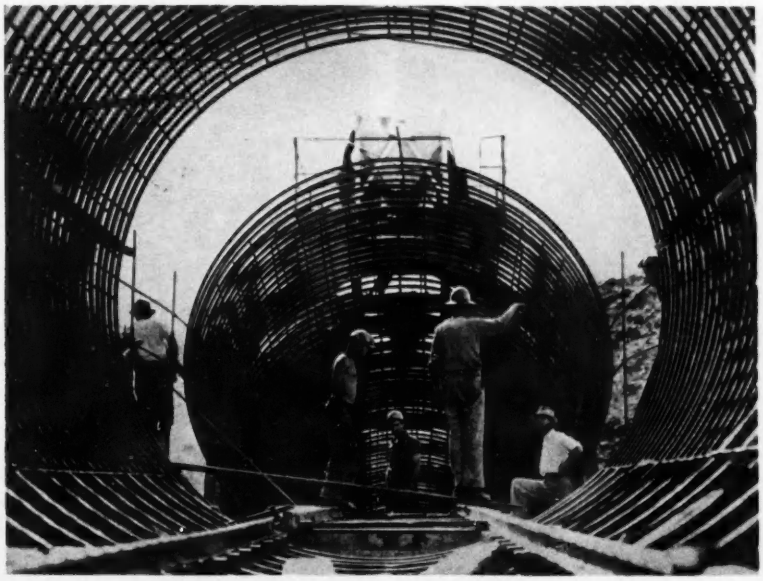
October 15, 1936



DOUBLE SQUIRREL CAGES of reinforcing bars for the siphon were carefully set to line and grade before concreting began.

Monolithic Concrete Siphon Built on Steep Grade

Overhead cableway handled steel, forms and concrete for Eagle Mountain siphon on Colorado River aqueduct, 12 ft. 4 in. in diameter and carrying a head of 158 ft.

By John Stearns

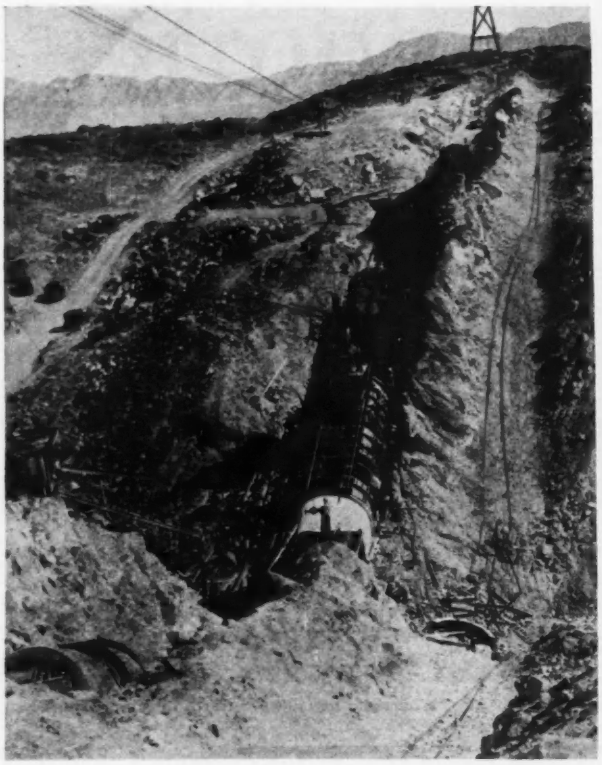
Division Engineer, Division 3, Metropolitan Water District of Southern California

TRUCKS that hauled their loads up 30 per cent grades and an overhead cableway that had to be moved during construction were the essential tools in solving construction problems on the recently completed Eagle Mountain siphon of the Colorado River aqueduct, now being built by the Metropolitan Water District of Southern California. Eagle Mountain is in the rough terrain to the west of Division 3 headquarters, about 110 miles from the Colorado River intake and some 200 aqueduct miles, east of Los Angeles. It is one of the many separate parts that ultimately will be combined into a great aqueduct for bringing 1,600 sec.-ft. of water across the desert to cities of the Los Angeles metropolitan area.

Eagle Mountain siphon begins at the surge chamber which tops the Eagle Mountain pump lift, a 438-ft. lift which is the fourth in the series of five pumping plants as counted from the intake on the Colorado River. This particular siphon has a length of 1,439 ft. and at its low point will be under a head of 158 ft. The completed structure will have two barrels, each with a diameter of 12 ft. 4 in. and a capacity of 802.5 sec.-ft. Only one of the barrels is being constructed at the present time; the second barrel is to be added when the demand for water justifies the additional expenditure. However, to avoid risk of damage to the existing barrel from blasting when the second barrel is installed later, excavation for both barrels was made before construction of the first barrel was started.

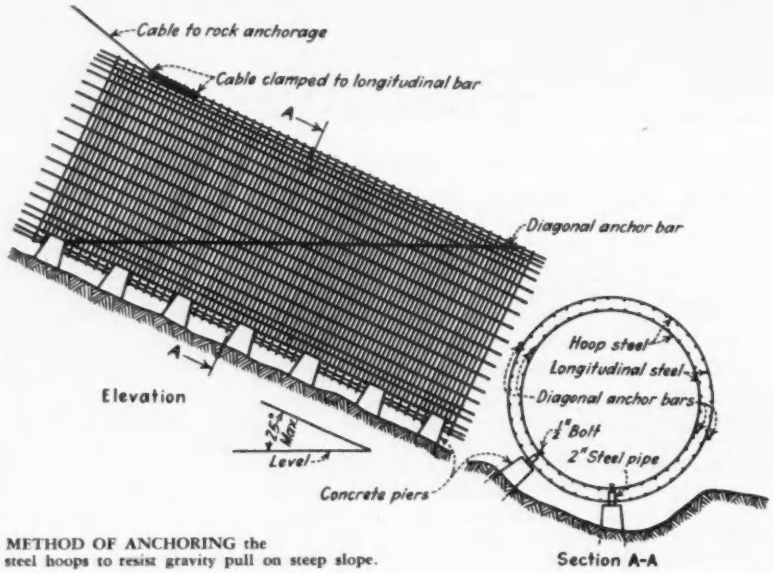
Construction of the first barrel involved the placement of 960,000 lb. of reinforcing steel and 3,075 cu.yd. of concrete. An important feature of the job was to provide some means for delivering materials, construction equipment and forms to points along the rugged slopes where the siphon had to be built. The most feasible road location involved grades of 30 per cent. For hauling over this road the trucks were equipped with special auxiliary transmissions, known as compounds, in which there is a lower gear ratio than is obtainable with standard equipment.

Because it was impracticable to deliver by truck to all parts of the siphon a cableway was erected to span the gorge crossed by the siphon trench. A horizontal curve in the siphon made it impossible to reach all of it from a single cableway location, and as there was no



SIPHON CONSTRUCTION under way. Completed concrete, steel forms and reinforcing hoops are shown in successive stages.

A WORM CRAWLS over the mountain to form a siphon on the Colorado River aqueduct. The size of the siphon may be gaged by the man standing on the top at the right.



METHOD OF ANCHORING the steel hoops to resist gravity pull on steep slope.

room for a track on which a movable tower might be shifted, the alternative of making two set-ups of the cableway was adopted. That is, after the first portion of the siphon had been completed both towers of the cableway were moved to a new position whence delivery of forms, reinforcing steel and concrete could be made to the remaining 954 ft. of siphon. A 7-ton cableway was found sufficient for handling the sections of steel form and accordingly this capacity was used. The main cable had a diameter of 1¼ in. and the hoist was operated by a 75-hp. gasoline engine.

Concrete was batched dry at the bottom of the pump lift, about ¼ mile from the site selected for the concrete mixing plant. The mixing plant, of course, had to be accessible both to the truck road and to the cableway. A separate plant set-up was made for each of the two cableway positions. A 1-yd. mixer was used, operated by a gasoline engine; delivery was direct from the mixer to 1-yd. cableway buckets.

Because of the high head under which the lower portion of the siphon will operate it was necessary to secure an extremely high-grade concrete job. Particular attention was given to preparation of the invert, all loose material was removed, and care was taken to key the concrete into the rock. Specifications called for concrete with a minimum strength of 3,000 lb. in 28 days. The aggregate was made up of 53 per cent of 1½-in. rock, 12 per cent of pea gravel and 35 per cent of sand. About 16 per cent of the sand would pass a 48-mesh screen and would be retained on a 100-mesh screen. Seven sacks of cement per cubic yard were used. With this mix the final average of tests showed a compressive strength of 3,900 lb. per sq.in.

The steepest slope on the siphon, just west of the low point, was a 25-deg. incline. This was steep enough to require some means of holding the reinforcing steel at the desired angle. The design of the greater portion of the siphon barrel called for double squirrel-cage steel with both inside and outside hoops of 1½-in. square rods spaced 5½ to 6½ in. on

DELIVERING CONCRETE from an overhead cableway. Concrete weights were used to keep the form sections from floating.

STEEL FORMS were moved ahead in 5-ton sections as the work progressed up the slope. The cableway was designed for the 5-ton load.

centers. These hoops were tied together with ¾-in. round longitudinal bars spaced 10 in. on centers. When the hoops were placed at right angles to the slope on the steep incline, the overhang was such as to require well anchored supports to resist the gravity pull. This support was provided by diagonal bars, placed in groups of four in each 20-ft. longitudinal section of the steep part of the siphon. Two of these diagonals were wired to hoops on the inside and two to hoops on the outside, as shown in the accompanying sketch.

In addition to these diagonals it was necessary to add a cable tie to a rock anchorage above. This was done by passing a loop of the cable around several hoops at the crown of the arch, clamping it to the longitudinal bar, and carrying the opposite end of the cable to some convenient anchorage in the rock above. On the steep portions of the line, cables of this sort were attached to the siphon at 20-ft. intervals.

Two-inch steel pipes were set in concrete piers, as shown on the sketch, for the purpose of supporting the outside and inside reinforcing steel assemblies. Each of these pipes was provided with a ½-in. bolt and tapered cone, adjusted so as to hold the inside forms on exact grade. After the concrete was placed between the forms the tapered cones were removed and the holes were filled with grout.

Steel forms were used both inside and outside except in the curves, where gores made it necessary to supplement the standard steel form. In all cases the gores were made of fiberboard built up in the shop to meet the specified curvature. The forms were fitted very carefully at all joints and the entire form surface was thoroughly coated with linseed oil before placing concrete.

The result of this care with interior forms was apparent in the remarkable freedom from imperfections on the inside of the finished concrete. No rock pockets were found, the fins were easily ground off, and small blowholes caused by air trapped in some locations along the invert were not so deep that they could not be entirely ground out, thus giving finished smoothness of a high order.

Immediately after stripping the inside forms the concrete was kept continuously wet by a water spray for fourteen days. After wetting down the concrete upon removal of outside forms, two coats of coaltar cutback were applied immediately.

Before testing the siphon by filling it with water, a specially designed grout machine was used inside the siphon to test the tightness of each circumferential joint. This special equipment consisted of a movable carriage supporting an adjustable ring encircled by a heavy rubber gasket, which was made to tighten against the concrete by expanding the ring with jacks. After expanding the ring to an airtight position, grout was applied to a pressure exceeding the working head, through connections welded into the ring. In only four cases could any grout be forced into the joints, and even in these cases the amount of grout taken was negligible.

All work on the Colorado River Aqueduct is carried out under the general direction of F. E. Weymouth, general manager and chief engineer of the Metropolitan Water District. J. L. Burkholder is assistant general manager, Julian Hinds is assistant chief engineer, and James Munn is general superintendent.

Capacity Margin of Continuous Girders

Continuous girders have a margin of capacity above the load that produces failure (yield point) stress in the critical section, according to test results of Prof. A. Maier-Leibwitz, of Stuttgart, Germany, reported in *Der Stahlbau* of Sept. 25, 1936. When the limiting stress in the critical section is reached, stretch transfers moment to other sections and thereby relieves the critical section. Application of this result to design practice presents possible economies in certain cases. Continuous purlines, for example, are stiffer and have greater security than purlines of simple or cantilever spans.

Plate Girders of Plywood Tested to Failure

TWO PLATE GIRDERS with plywood webs and 2x4-in. timber flanges were recently tested to failure in the engineering laboratory of the University of North Dakota at Grand Forks. One girder was assembled with bolts and split ring connectors, the other with casein glue. The original design for the girder with split ring connectors contemplated flanges of two 2x6's and a web of $1\frac{5}{8}$-in. plywood, but a strike in the plant where the web was to be fabricated prevented this part of the plan from being carried out. Accordingly, the web was made from two $\frac{3}{4}$-in. thicknesses of commercial plywood cut to size and fastened together under pressure with casein glue. The assembly proved effective since there was no evidence of separation of the glued surfaces during the tests.

Ring connectors

The split ring connectors used were $2\frac{1}{2}$ in. in diameter and $\frac{3}{4}$ in. wide, imbedded equally in the flange and the web. The bolts were spaced in general 6 in. apart, but there was only one ring for each bolt since the thinness of the web prevented rings being placed opposite one another. Thus the rings were staggered 12 in. apart except at the ends.

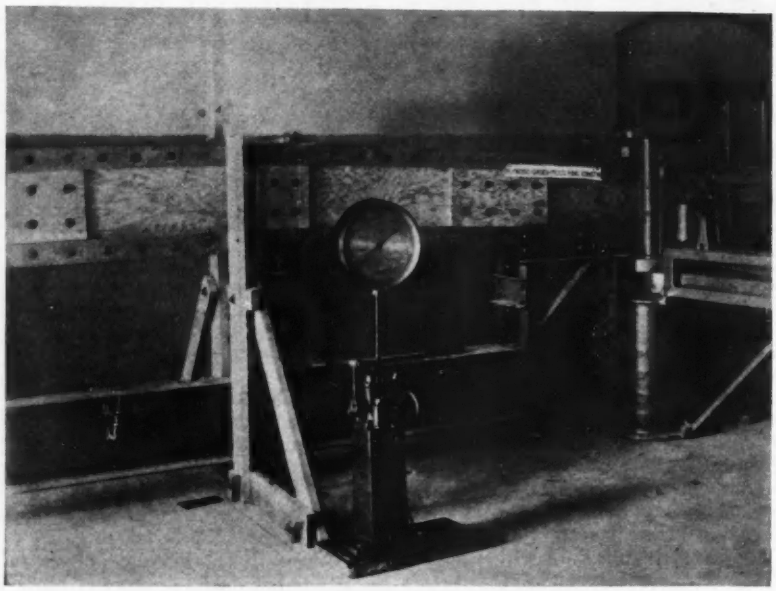
In the testing apparatus, a 15-in. I-section was used as a jacking beam, attached through a bracing frame at one end to the weighing table of a 25,000 lb. testing machine. The load was applied by means of a hydraulic jack at the center (Fig. 1.) A wood frame at the center prevented the lateral buckling of the compression flange. The total central load was shown on the pressure gage on the jack, and one-half of this load was indicated on the beam of the testing machine.

Deflections were measured from a fine wire stretched between two nails along the axis of the beam, a spring being inserted near one end of the wire to keep it taut. A steel scale was placed behind the wire. The following table gives the readings for the central load and the deflection:

Central Load (lb.)	Deflection in.
10,000	0.49
20,000	1.20
22,000	1.35
25,000	1.65
27,200 (breaking load)	—

The break occurred in the tension flange at the center.

FIG. 1—PLYWOOD PLATE GIRDER under test with a load being applied at the center.



Glued girder

The glued girder was made up with a $\frac{3}{4}$-in. plywood web and 2x4-in. flanges fastened with casein glue. This girder had a depth of 18 in. as compared to 20 in. for the other girder and a span of $13\frac{1}{2}$ ft. as compared with 15 ft. 2 in. The load deflection table for the glued girder was as follows:

Central Load (lb.)	Deflection in.
5,100	0.25
12,000	0.49
18,000	0.87
22,000	1.45
22,100 (breaking load)	—

The first break in the glued girder was also in the tension flange, followed almost immediately by longitudinal shear in the web just below the top flange at the end, a result of the relatively thin web that was used.

The tests were carried out under the direction of Alfred Boyd, professor of civil engineering, at North Dakota University.

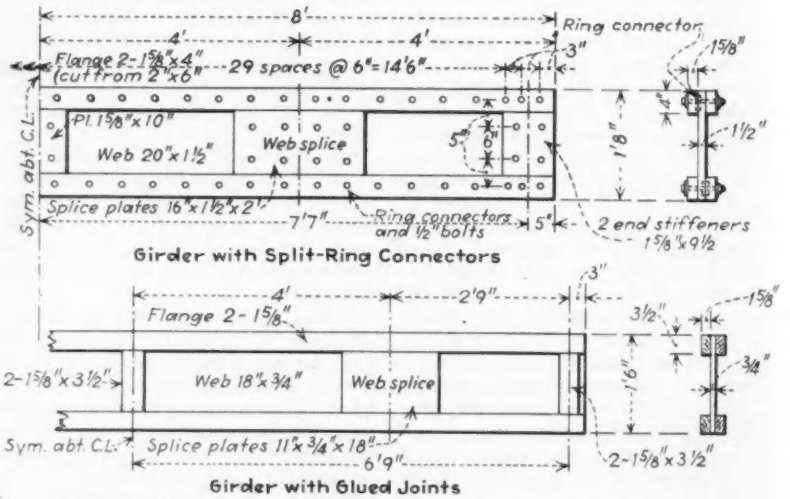


FIG. 2—MAKE-UP OF PLYWOOD PLATE GIRDERS, one assembled with split ring connectors, the other with glue.

Sewage Treatment for Denver

Disposal plant of 54 m.g.d. capacity includes pre-aeration, chemical treatment, filtration by means of rectangular down-flow magnetite units and separate sludge digestion. Additional dilution water to be supplied to stream receiving plant effluent

AWARD of the construction contract for sewage disposal works at Denver, Colo. on June 10, marked an important step in the general program which has as its objective the elimination of the nuisances caused by the discharge of untreated Denver sewage into the Platte River. The entire project includes the extension of the several existing outfall sewers to a junction chamber at the disposal plant site and the diversion of water from the western slope for dilution during periods of low-river flow. The sewer extensions, which will cost about $200,000 are now being constructed with WPA labor and the plans for the transmountain diversion project which will bring water from the upper reaches of William Fork of the Grand River, which is expected to cost approximately $1,500,000, are in course of preparation. It is expected that the sewage disposal works will be completed and in full operation within a year.

Denver is sewered on the separate plan and the sanitary sewer system, which comprises four separate districts, serves 85 per cent of the population and practically all of the developed property within the city limits as well as some suburban property. About 262,500 persons were served in 1934 and it is estimated that the sewered population in 1948 will include more than 317,500 persons.

Sewage flow owned by state

Due to existing river regulations the sanitary sewage of Denver is a part of the flow of the South Platte River and is subject to appropriation for use for irrigation or other purposes. The title to the sewage flow lies with the state rather than with the city and legally the sanitary sewer system lies in about the category of a tributary stream. The flow of the South Platte River, including the sewage of Denver, is now greatly over appropriated and since the sewage constitutes an average of 21 per cent of this flow, the importance of the irrigation feature is evident.

Careful gaugings made during the past few years at the several outfalls show that the sanitary sewage flow has decreased from an average of 48 m.g.d. in 1927 to an average of 39 m.g.d. in 1934 in spite of a steady increase in the number of people served. This reduction is shown in the following table and is probably the reflection of constant efforts on the part of the Denver water officials toward water conservation, although some of it is undoubtedly due to the series of hot, dry years between 1930 and 1935.

Plant design has been based on an average daily flow of 54 m.g.d. which corresponds to a per capita rate of 170 gal. per day from a population of 317,500.

Character of sewage

Due to relatively low-water temperatures and to ample gradients in the sewer lines the sewage reaches the outfalls in relatively fresh condition. Hydrogen sulphide is generally absent and dissolved oxygen is commonly found during the early morning hours. Packing-plant sewage, which is the only industrial waste encountered in sufficient quantity to constitute a factor in treatment, is produced in an area within one-half mile of the proposed plant site and may be expected to reach the plant before decomposition has progressed to any great extent.

Based on a series of tests made on composited samples from the several city outfalls and from the packing house sewers, the plant has been designed to treat sewage containing 202 p.p.m. of B.O.D. and 151 p.p.m. of suspended solids. On a per capita basis this corresponds to 0.283 lb. of B.O.D. and 0.22 lb. of suspended solids per day and represents a sewage somewhat stronger than average for cities of the size of Denver.

The average flow of the South Platte River at Denver is 260 sec.-ft. and that of the city sewage is 69 sec.-ft. or 21 per cent of the total river discharge below Denver. The minimum river flow is 25 sec.-ft. It is estimated that safe disposal by dilution would require a minimum stream flow of 4,500 sec.-ft. and such flows occur only at extra flood stages. As a matter of fact this flow has occurred on only 28 days during the period from 1889 to 1935.

Naturally the dicharge of this large volume of sewage has caused nuisances along the river and in the various irrigation ditches. Since 18,000 acres, of the 130,000 acres irrigated from the

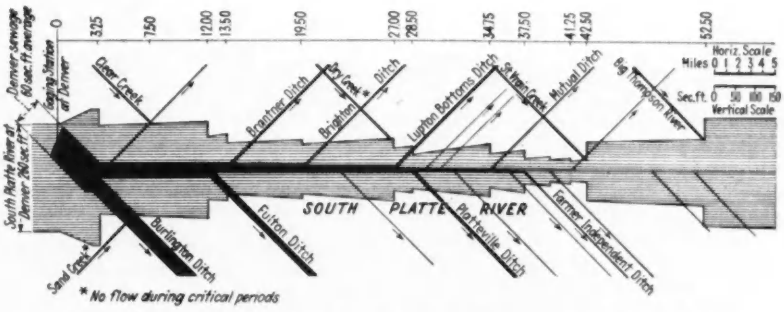


FIG. 1—DIAGRAMMATIC REPRESENTATION of Platte River flow below Denver showing entrance of sewage and tributaries and diversions to irrigation canals.

TABLE I—FLOW OF DENVER SANITARY SEWAGE SHOWS MARKED DECREASE SINCE 1927

Year	Tributary Population	Aver. and Daily Sewage Flow M.g.d.	Gal. per Capita	Percentage of Aver. Day Max. Day	Min. Day
1927	245,400	47.98	195.5	130	85
1928	248,000	48.51	195.6	200	82
1929	250,600	48.48	193.5	132	76
1930	253,200	46.69	184.4	135	81
1931	256,300	46.41	181.1	118	82
1932	258,400	44.13	170.8	132	82
1933	260,500	42.38	162.7	167	84
1934	262,500	39.19	149.3	115	86

South Platte River immediately below Denver is devoted to intensive truck gardening, a definite health menace exists. A study made by the Colorado State Board of Health in 1932 led to the following significant findings: (1) That the South Platte area with only 11 per cent of the state population produced 19 per cent of the typhoid cases in 1930 and 29 per cent in 1931. (2) The number of typhoid cases in Colorado as a whole decreased by 7 per cent from 1930 to 1931 while, during the same period, the number of cases in the South Platte area increased 10 per cent.

That conditions below Denver have not been unbearable can be explained only by the fact that an amazingly large amount of natural purification has taken place in the shallow stream bed and sluggish irrigation canals as well as on the irrigated land itself.

Fig. 1 shows the path of the Denver sewage after its discharge into the river. This chart is necessarily only approximate since river conditions vary continually but it does represent a reasonable average. About 46 per cent of the Denver sewage is diverted at the northern city limits and 90 per cent of the remainder is diverted in the succeeding 40 mi. of river. This diversion, together with the dilution afforded by tributary streams and by return water from the irrigated land on both sides of the river and the natural purification in the stream bed, causes the sewage to lose its identity within a relatively short distance. Since the greater part of the sewage solids has been deposited in the stream bed and in the canals near Denver, most of the nuisance has occurred at these points.

It is evident that the disposal problem at Denver is intimately related to irrigation and that the principal requirement of sewage treatment is the removal of solids. Further secondary treatment by oxidation is relatively unimportant in view of the excellent opportunity for natural purification afforded by the irrigation systems.

The Board of Heath of Colorado has set the limit of allowable pollution below Denver at 40 p.p.m. of B.O.D. and in order to meet this requirement with primary sewage treatment it is estimated that an average of 12,000 acre-ft. of dilution water will be required per year in addition to the natural river flow. It is proposed to divert this water from the Williams Fork of the Grand River and to convey it to the eastern slope by means of a tunnel which will discharge into Clear Creek and enter the Platte River through the White Cap canal immediately above the first diversion below Denver.

The required amount of diluting water will vary from year to year and in order to be independent of possible dry periods, provision for coagulation with chemicals and filtration has been made in the sewage disposal works. Whether the restrictions as to river pollution can be met more economically by dilution or by additional chemical treatment will depend on current conditions as regards stream flow, cost of chemicals and availability of diluting water.

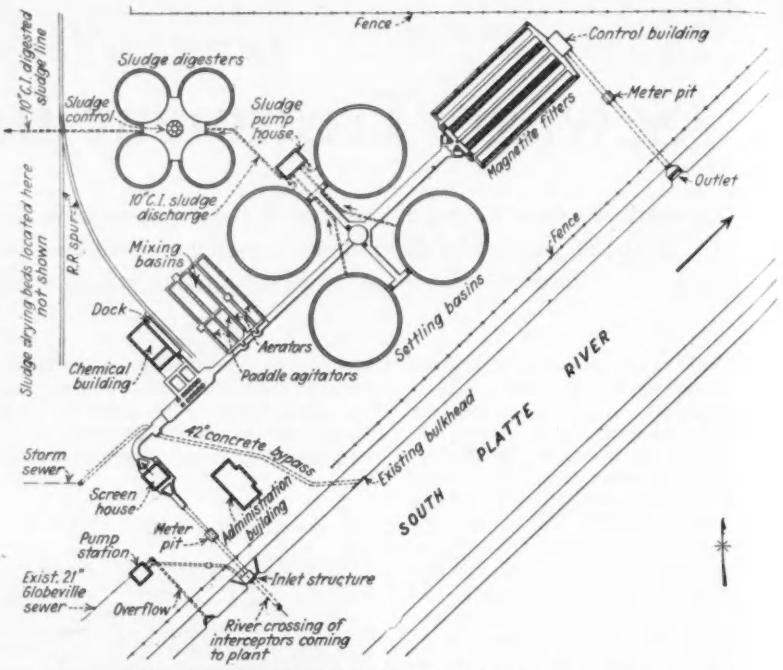


FIG. 2—DENVER SEWAGE DISPOSAL PLANT provides for chemical treatment, sedimentation, filtration by means of rectangular down-flow magnetite units and separate sludge digestion facilities.

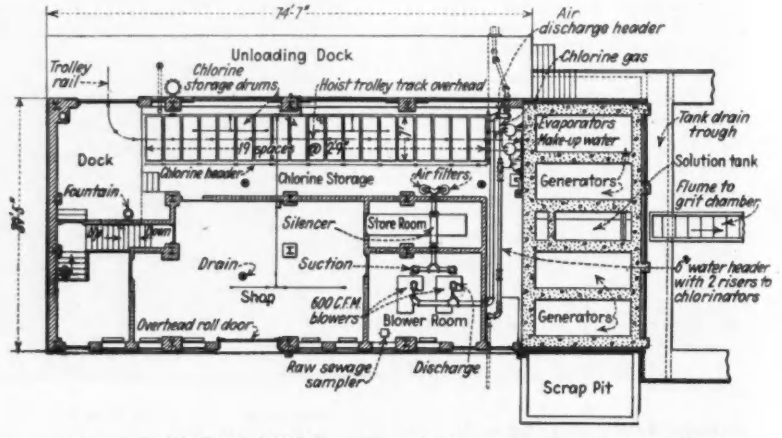


FIG. 3—CHEMICAL BUILDING has separate chlorine container compartments and tanks for generation of chlorinated copperas.

The treatment process

The disposal works are to be located on the west side of the river just south of the northern boundary of the City and County of Denver and will include the following major processes: Screening, grit removal, pre-aeration and grease removal, coagulation with lime and ferric salts, sedimentation, filtration through magnetite sand, sludge digestion in separate tanks and air drying of digested sludge on open beds.

Sewage will enter the plant through a concrete junction chamber which is the terminus of the system of collecting sewers. A 78-in. gravity line will be carried across the river and will enter from the east, one 42-in. pressure line will enter from the southwest and the discharge line from a pumping station which serves the low-lying district of Globeville will enter from the west.

The hydraulic gradient in the junction chamber will be at El. 5,147 which may be compared with that of the river levee which is at El. 5,143, the general level at the plant site which is at El. 5,137 and the river bed which is about El. 5,130. Normal high water at the plant site is at El. 5,136. The junction chamber is equipped with motor-operated sluice gates by which the total sew-

age flow may be bypassed and the pressure sewer has a valved blowoff connection to the river.

The sewage is taken out at the bottom of the junction chamber by means of a pressure pipe which leads through a venturi meter to an uptake shaft at the entrance to the screen channels. The venturi meter is connected electrically to an indicating device to be set in the chemical building and to a device for indicating, recording and totalizing flows which is to be located in the operating room in the administration building.

At the screen house the sewage is divided and carried in three 5-ft. channels through the building which houses three mechanically-cleaned bar screens with ¾-in. openings. Screenings will be diverted through shredders and returned to the sewage flow to be handled as sludge.

The screened sewage goes through an overflow chamber fitted with longitudinal weirs which automatically bypass flows in excess of 90 m.g.d. and it then enters one or both of two grit channels equipped with mechanical cleaning devices of the straight-line type.

The grit-free sewage passes on to an aeration tank equipped with a mechanical skimming device. The tank is in two passes and has a detention period of 15 min. Compressed air from blowers located in the chemical building will be admitted through porous plates set along one side of each tank. An allowance of 0.05 cu.ft. of air per gallon of sewage has been made. Coagulant is added in a short stretch of flume between the grit chamber and the aeration tank. The aerated sewage passes through a port into the mixing chamber which will be equipped with mechanical agitators of the paddle type.

After a 15 min. period of mixing the sewage is conveyed in a flume to a central feed well which serves four 140 ft. circular settling tanks of the central feed and peripheral overflow type. An average detention period of 2 hr. and a settling rate of 877 gal. per sq.ft. per day with a weir length of 1,759 ft. or 32½ lin.ft. per m.g. has been provided.

The settled sewage will be filtered through 3 in. of magnetite sand having an effective size of 0.5 mm. Six filter units with a total area of 14,000 sq.ft. will be provided and each unit will be equipped with a solenoid-operated cleaning device. The normal rate of filtration will be 2.68 gal. per sq.ft. per min. and, since flows in excess of 80 m.g.d. will be bypassed after settling, the maximum rate of filtration will be 4 gal. per sq.ft. per min. Wash water will be returned to the pre-aeration tank for retreatment.

Sludge gas stored

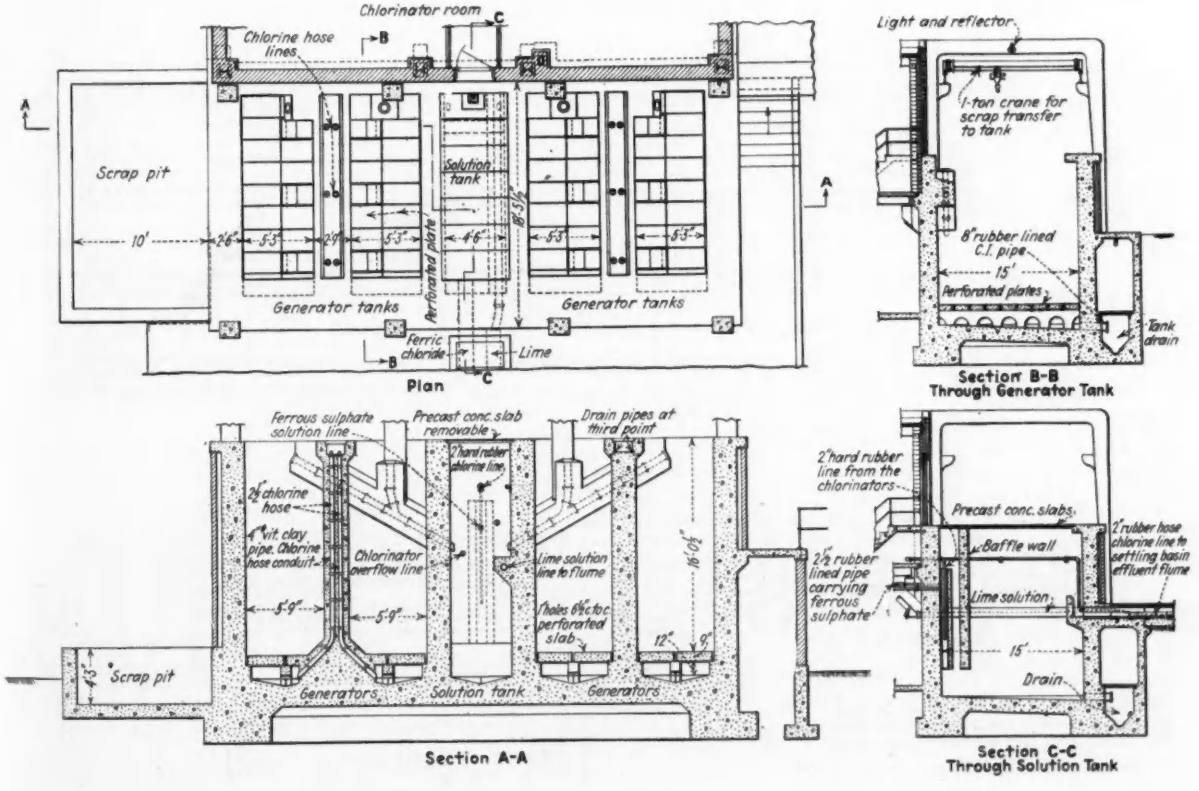
The solids removed as scum from the skimming tanks and as sludge from the settling tanks will be pumped into a battery of four sludge digesters, each of which is 85 ft. in diameter and 30 ft. deep. The tanks will be equipped with floating covers of the Downes type and one of them will be fitted with an extension rim to permit of its use as a gas holder. The temperature in the tanks will be controlled by the circulation of hot water from individual boilers fired with gas from the digestors. The boilers, auxiliary equipment and the various systems of piping for gas, digested sludge, raw sludge and supernatant liquor will be housed in a building which will occupy the space between the four digestors, since this arrangement makes for economy in the piping layout and convenience in operation.

The digestion tanks are equipped for the progressive movement of digested sludge and supernatant liquor but not for the recirculation of sludge or for the mixing of raw and digested sludge in individual tanks.

The four digestion tanks have a total capacity of 681,000 cu.ft. or about 2 cu.ft. per capita (inclusive of equivalent industrial load) or, more exactly, 22 cu.ft. per lb. of volatile matter added per day. Provision for the storage of 30,000 cu.ft. of gas has been made by extending the rim on one of the floating covers.

Sludge from the settling tanks will be handled by individual sludge pumps each of which will be operated through an adjustable time switch. Scum from the skimming tanks and from the settling tanks will be delivered by gravity to a sump in the sludge-control building and will be pumped into the digestors.

FIG. 4—FERRIC CHLORIDE generator tanks, scrap pit and solution tank.



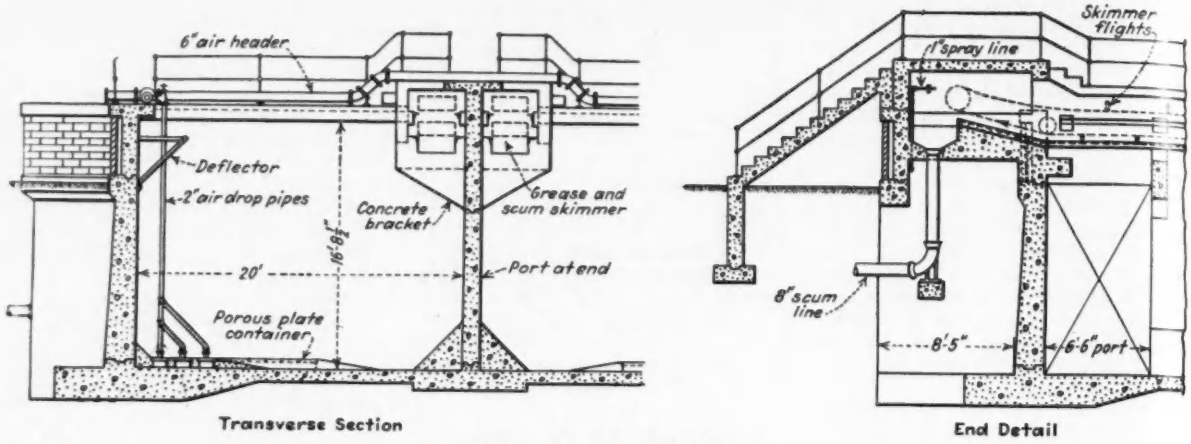


FIG. 5—MIXING BASIN details showing preaerators and grease and scum removers.

The digested sludge will be air-dried on sand beds. Sixty-eight beds, each 80 ft. by 100 ft. in plan, have been provided. Equipment for cleaning consists of two traveling belt conveyors. Each of these conveyors is 200 ft. long and will traverse thirty-four of the beds. Sludge will be shoveled into the conveyors by hand and will be deposited either into trucks or on stock piles located along the sides of the drying area.

Chemical handling features

Chemicals will be stored in and fed from a building located near the aeration tank and adjacent to a railroad siding. Storage in four steel bins will be provided for 200 tons each of pulverized quick lime and copperas. Pneumatic unloading equipment will be installed to handle these chemicals from the cars to the storage bins. Provision is made for the use of chlorine either from tank cars or from ton containers and in either case it will be removed as a liquid into heated evaporators from which the gas for the chlorinators will be obtained. Four solution-type chlorinators, each with a capacity of 2,000 lb. per day, will be installed and will discharge into a rubber-lined header so arranged that the chlorine may be distributed to the several reaction and oxidizing tanks.

On account of the distance from manufacturing points and high freight rates, commercial forms of ferric chloride and sulphate are too expensive for consideration and it is planned to use chlorinated copperas and ferric chloride manufactured at the plant from chlorine and scrap iron. With chlorine, in tank cars at $2.85 per cwt., and scrap iron at $5 per ton it is possible to produce ferric-chloride for $37 per ton which corresponds to a cost of $0.0568 per lb. of ferric iron. With copperas at $26 per ton the chlorinated copperas product can be produced at a cost of $48 per ton of mixed ferric salts or at about $0.077 per lb. of ferric iron.

For the manufacture of ferric chloride, four reaction tanks with false bottoms of concrete blocks have been provided. Iron in the form of crushed tin cans, lathe runnings or small scrap will be placed in the reaction tanks and a 0.34 per cent solution of chlorine will be introduced below the false bottom and will pass upward through the iron to a

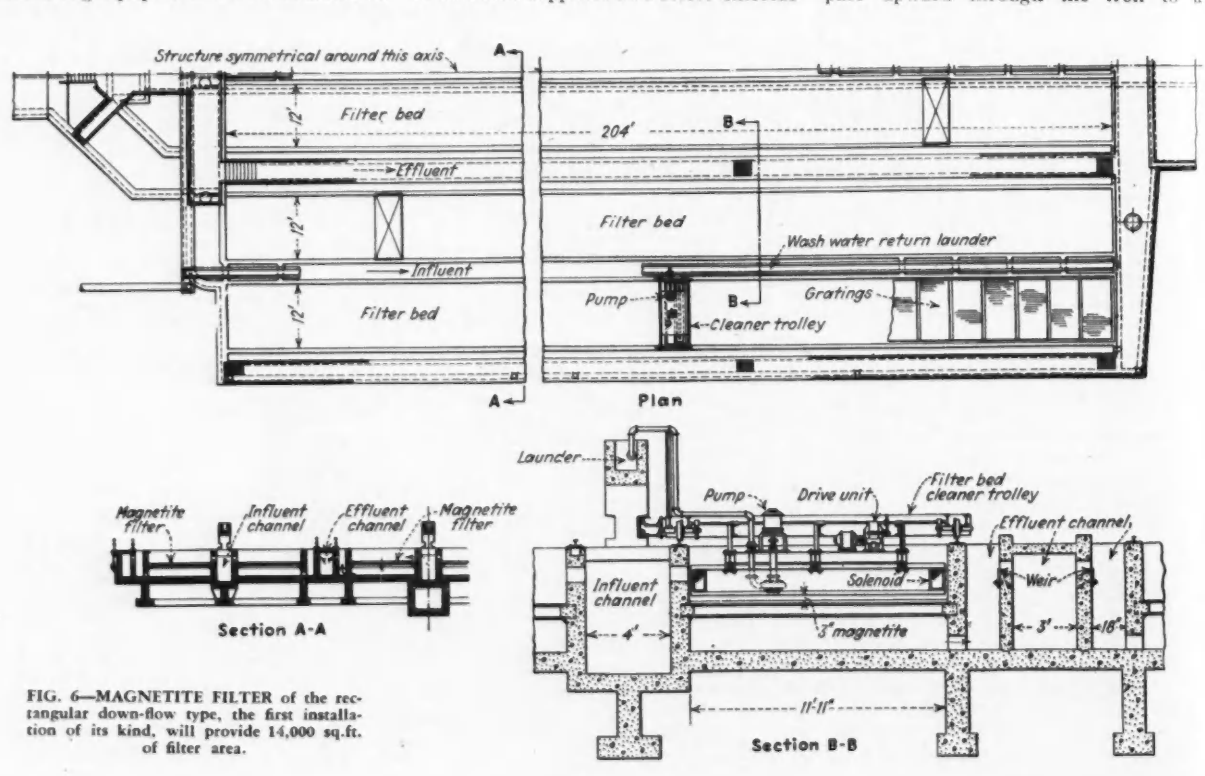


FIG. 6—MAGNETITE FILTER of the rectangular down-flow type, the first installation of its kind, will provide 14,000 sq.ft. of filter area.

drawoff line located at the water level. Three of these tanks will be used in parallel and will afford a reaction period of 90 min. The fourth unit will be used as a standby. There is some doubt as to the efficiency of the manufacture of ferric chloride in this manner but experience with other installations indicates that 4,100 lb. of iron may be put into solution per day under the conditions described above. Some of this product may be expected to be in the ferrous state and in order to oxidize this portion the solution from the reaction tanks is discharged into a final tank where additional chlorine may be added. While this method of producing ferric chloride appears to be economical it is rather cumbersome and does not lend itself to the rapid adjustment which will be required to meet the rapidly changing quantity and quality of the raw sewage. Furthermore the ferric chloride so produced, is quite dilute (0.5 per cent solution) and storage is impractical. Therefore provision has been made for feeding copperas into the oxidizing tank from dry-feed machines and for feeding additional chlorine as needed to make up the required dose of ferric iron.

The plant operation will be directed from an administration building which will contain offices for the superintendent and the chemist as well as a completely-equipped sewage laboratory and a general operating room which will accommodate the main switchboard and the various recording instruments. The basement of the administration building will be used as a garage. The various plant structures have been designed for harmony from an architectural standpoint and will be constructed of glazed tile. Provision for adequate yard lighting has been made and the grounds will be landscaped by the city park department upon the completion of the construction work.

CONSTRUCTION COST OF THE DISPOSAL WORKS

Preliminary clearing and grading at the plant site	$11,900
Mechanical equipment	114,351
General contract	1,149,792
Total	$1,276,043

The contract for clearing and grading included 25,000 cu.yd. of excavation and the removal of trees and a few buildings on the plant site which covers 43.6 acres.

The mechanical equipment which was purchased direct from manufacturers prior to the design of the structures cost $114,351 and includes the following items: Three mechanically cleaned bar screens with individual shredders; equipment for two grit chambers; four 140-ft. circular clarifiers; four floating covers for 85-ft. circular digesters; five 150-g.p.m. centrifugal sludge pumps; two traveling belt conveyors with 200-ft. span for sludge beds; two chlorinators, each to handle 1,000 lb. of chlorine per day.

Peter Kiewit's Sons Co. of Omaha, Neb. has the general contract for the disposal plant and started active operations the latter part of July. The works financed through bond issue and PWA grant were designed by Black & Veatch, consulting engineers, Kansas City, Mo., and construction is being supervised by A. K. Vickery, city engineer.

CONSTRUCTION COST ANALYSIS OF THE DENVER SEWAGE TREATMENT WORKS

Unit	Contract Cost	Per Cap.	Per M.g.d. Daily Cap	Volume or Area	Cost per Unit of Vol. or Area
Screen plant	$34,342	$0.107	$636	.....	.....
Grit chambers	27,571	0.086	510	.....	.....
Pre-aeration & mixing tanks	81,023	0.257	1,500	151,200 cu.ft.	$0.53
Settling tanks	162,914	0.513	3,020	830,400 cu.ft.	0.20
Digesters	211,678	0.660	3,920	681,000 cu.ft.	0.31
Filters	255,151	0.800	4,720	14,000 sq.ft.	18.20
Chemical bldg.	127,380	0.400	2,360	215,040 cu.ft.	0.59
Administration bldg.	57,354	0.180	1,062	84,500 cu.ft.	0.68
Sludge beds	92,928	0.290	1,721	544,000 sq.ft.	0.17
Clearing, grading & excavation	64,150	0.200	1,180	.....	.....
Sludge pump. sta.	14,000	0.044	260	.....	.....
Miscellaneous structures, fencing & driveways	52,008	0.164	965	.....	.....
Yard piping Venturi meters & electric wiring	95,544	0.30	1,770	.....	.....
Total	$1,276,043	$4.02	$23,630	.....	.....

Sound Asphalt Road Mix Made With Ordinary Concrete Sand

Sands suitable for cement concrete make a stable mix for pavement by proportioning the bitumen filler to suit voids in the sand

By F. S. Besson
Lt.-Col., Corps of Engineers, Office of Chief of Engineers, Washington, D. C.

DURING a period from fifteen to twenty years ago, while studying the existing asphalt pavements in the District of Columbia, pavements at that time ranging up to more than forty years old, I developed some ideas about the technique of hot asphalt mixtures, particularly in regard to: The use of usual portland cement concrete sands instead of asphalt sands graded in accordance with arbitrary sieve analyses; the function of 200-mesh filler in asphalt mixtures; the elimination of the binder course, and the adequacy of a 1-in. asphalt surface on a stable base.

Actual voidages studied

Observation of District of Columbia sheet asphalt pavements showed that they might be divided into three classes—cracked, good and waved.

Naturally, the percentage of bitumen required for an asphalt mixture varies with the voidage of the mineral aggregate in the mixture. Accordingly, the first step of investigation was along the line of aggregate voidages. The laboratory collected a great number of samples from the streets, from pavements of all ages up to 42 years, and of many different mixtures. Analysis of these samples gave a curve drawn with bitumen percentages as ordinates and aggregate voidages as abscissas. Samples from good pavements fell on this curve; from cracked pavements, below the curve; and from waved ones, above the curve. However, many specimens from poor pavements, seemed to be abnormal and fell on the curve. In fact, the curve measured the bitumen-voidage relationship but not the bitumen-filler relationship.

Thus we had trouble immediately, when attempting to fix bitumen requirements for untried aggregates, as for example, usual portland cement concrete sands, or, to use an extreme example, standard Ottawa sand. The sizes of the void spaces have more influence on bituminous mixtures than do void percentages.

Function of filler

While it may be said that pavement mixtures consist of two elements, bitumen and aggregate, the latter really includes a third component, filler, which may be either limestone dust, portland cement, slate dust or other finely divided material. The statement often made, that filler is added to sand to reduce the voidage, is not absolutely correct. For instance, with Ottawa sand, the voidage is nearly constant at 42 per cent for dust admixtures of from zero to 40 per cent.

Generally, with the addition of filler there is little change in the total volume of voids, but the individual spaces are multiplied in number and decreased in size. The bituminous cement is thereby spread throughout the mixture in very thin films, and is less susceptible to temperature changes than if it were sub-

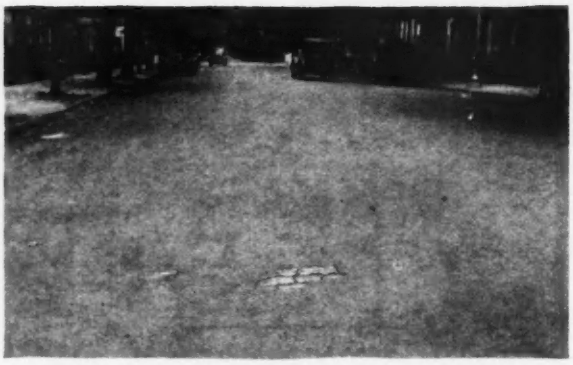


FIG. 1—SURFACE feathered to ¼ in. at granite block high spot holds firm

FIG. 2—INCH-THICK LAYER along gutter keeps its original alignment almost perfectly

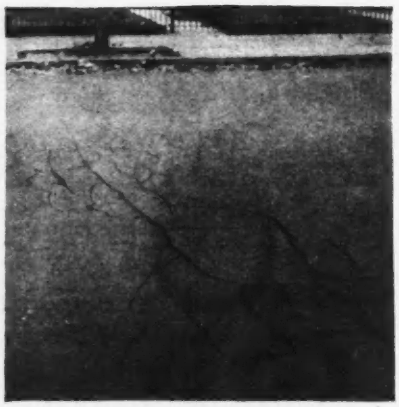


FIG. 3—ALLIGATOR CRACKING over a soft area in the subgrade

divided among but a few void spaces, each of relatively large volume.

It used to be general sheet asphalt practice to adhere to one or another of several well known or patented formulas in accordance with specified arbitrary sieve analyses. These blended aggregates were usually expensive, in some parts of the country too costly to be considered.

I felt that if a sand were good for a portland cement concrete mixture, it should be good for an asphalt cement mixture. Realizing that mixtures made with straight portland cement concrete sand would be unstable, it was necessary to determine how much filler should be added to the sand for stabilization. But at the time of my investigation, there was no method known for the laboratory determination of the best proportion to use. With almost constant voidage, as the proportion of filler varied, it was evident that the bitumen aggregate curve, just constructed, was useless for this filler determination.

Studies of this question of the use of portland cement concrete sand with filler brought forth the development of a stability test. Using samples taken from the streets, the laboratory made standard compressed blocks and tested them by standard impact delivered on a steel pin set over the center of each block. The tests covered the following temperatures, 32, 50, 80, 110, and 140 deg. F.

Mixtures from cracked pavements were friable at 32 deg., and the blocks broke into small pieces under a single blow. At 140 deg. blocks from the cracked pavements broke in two under the last of four blows, comparing favorably with specimens for good pavements tested at lower temperatures.

Mixtures from waved pavements were soft at high temperatures. At 140 deg. the pin penetrated under one blow without cracking the blocks. At 32 deg. blocks from these waved pavements broke into two or three pieces under the last of several blows, comparing favorably with specimens from good pavements tested at higher temperatures.

Specimens from good pavements showed less variation with temperature than others, being not so brittle at low temperatures as specimens from cracked pavements, nor so soft at high temperatures as specimens from waved pavements.

With the tested specimen from the three classes of pavements as standards for reference, the laboratory made blocks using Potomac River portland cement concrete sand mixed with various proportions of limestone dust. Tests of these blocks showed that an admixture of approximately 18 per cent limestone dust with portland cement concrete sand resulted in a bituminous mixture with laboratory stability equal to that of the best mixtures in existing pavements in the District of Columbia.

Test road built

Having decided upon the correct mixture from a laboratory viewpoint, it was then necessary to lay an experimental stretch of pavement for service test. It was desirable to take advantage of this experimental pavement to test the ideas as to the elimination of the binder course, and as to the adequacy of a relatively thin surface sheet. Since 1886 there gradually had grown a persistent thought that sheet asphalt pavement must be laid with a 1½ in. binder course and a 1½ in. top course. True, the binder course adds thickness to the pavement and therefore adds strength, but not as much strength as can be obtained at less cost by increasing the strength of the foundation upon which the sheet asphalt is laid. With a 3-in. surface, the cost of patching is greatly increased. For each inch in thickness, a square yard patch requires approximately one cubic foot of hot mixture.

On 6th St. Southwest, in the District of Columbia, was an area of 17,000 sq.yd. of granite block pavement laid in 1871. Though occupying an important position in the city highway plan, because of general roughness and the many deep depressions, travel over it was slow and uncomfortable. Traffic counts showed only 330 vehicles from 6:00 a.m. to 6:00 p.m.

The surfacing gang, in spreading the newly developed concrete sand asphalt mixture, laid 1-in. screed boards 3 ft. from the gutter. This practice left a 3-ft. granite block gutter, justifiable because the roadway is 40 ft. wide and the gutters are occupied only by parked vehicles. The men on the job gave the old street no paint coat prior to spreading the surface mixture; the only preparation given the old surface was to remove the grass growing in the joints between the granite blocks. They laid the mixture to varying thicknesses to obtain a true surface. In the depressions they laid it to a depth of as much as 8 in. tamping the mixture to obtain good consolidation. In other spots the surface layer was as thin as ¼ in. with small areas of bare blocks showing at the extreme high spots.

Today, inspection can find no difference in the behavior of the surface course because of difference in its thickness. Fig. 1 shows one of the points where the surface tapers to a ¼ in. thick around a granite block high spot. The thin asphalt layer is as good as when laid 15 years ago. The condition of the 1-in. thick edge along the gutter, after 15 years of service, is shown in Fig. 2. After the improvement, traffic on 6th St. increased immediately. From the previous volume of 330 vehicles, 6:00 a.m. to 6:00 p.m., the daily average of the week following, increased to 1,850 vehicles. Passenger cars multiplied by eight, and trucks by five.

The initial cost of the improvement averaged 70c. per sq.yd. The approximate annual cost for maintenance has

been $170, or 1c. per sq.yd. Large areas have had no maintenance and are in excellent shape today. On the other hand certain areas have had relatively large maintenance. These areas contain soft spots in the subgrade, as for example where old utility cuts exist.

Fig. 3 shows an area of surface laid on a soft spot. This alligator cracking is typical of an unstable subgrade and cannot be charged against the surface mixture. In fact, the tenacity with which the surface stays in place under the unfavorable condition, is surprising, because when a truck passes over such a spot, the pavement flexes like rubber.

The 6th St. surfacing job is one step forward in proving that: (1) Hot asphalt mixtures made with inexpensive portland cement concrete sand and a high filler content are the equal of any; (2) That the binder course should be eliminated, and (3) Surface mixtures on stable bases need be only 1 in. thick.

Compressive and Flexural Strength of Concrete Compared

By William A. Blanchette
Highway Engineer,
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Washington, D. C.

AS A SUPPLEMENT to existing data pertaining to the relation between the compressive and flexural strength of concrete mixtures, the following analysis, based on data presented in an article entitled "Some new relations bearing on concrete mixtures," published in *Public Roads* for May, 1934 (vol. 15, no. 3), reveals some interesting relationships. The mixture, strength, and water-cement ratio data contained in the table were taken from table 4 and the slump data were taken from table 6 of the abovementioned article in which the materials used, the test procedure followed, and the results obtained are described in considerable detail.

The symbols used in that article and repeated here are as follows:

a = absolute volume of fine aggregate in a unit volume of freshly placed concrete

b = absolute volume of coarse aggregate in a unit volume of freshly placed concrete

c = absolute volume of cement in a unit volume of freshly placed concrete.

$b_s = \frac{b}{a+b+c}$ = ratio of the absolute volume of coarse aggregate to the sum of the absolute volumes of fine aggregate, coarse aggregate, and cement in a unit volume of freshly placed concrete.

Relative water content w is expressed in terms of the basic water content (1.00), which basic water content represents that volume of water which results in maximum density in the mixture.

The table shows for every mixture used the ratios of the solid ingredients, the relative water content, the compressive and flexural strength, the ratio of compressive to flexural strength, the water-

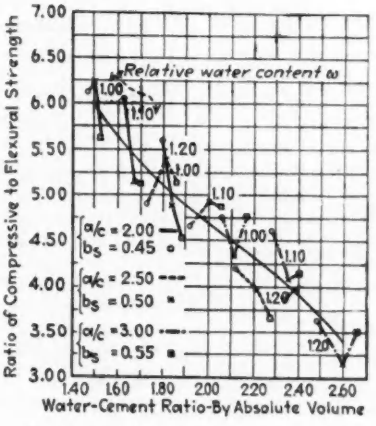


FIG. 1—EFFECT of water-cement ratio on the ratio of compressive to flexural strength.

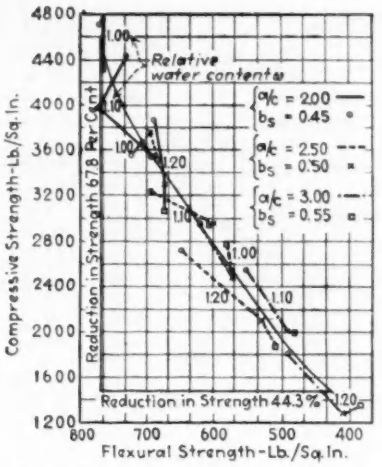
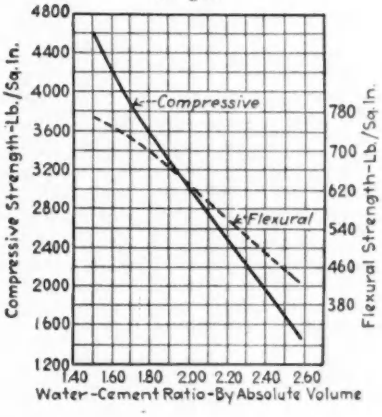


FIG. 2—COMPARISON of flexural and compressive strengths of mixes made with various water-cement ratios.

FIG. 3—WATER-CEMENT RATIO-CURVES for both compressive and flexural strengths.



CONCRETE TEST SPECIMEN DATA

a/c	bs	Relative water content w	Compressive strength[1] lb. per sq.in.	Flexural strength[2] lb. per sq.in.	Ratio of compressive to flexural strength	Water-cement ratio[3]	Slump in.
2.00	.45	1.00	4,716	771	6.12	1.47	1.50
2.00	.50	1.00	4,782	766	6.24	1.50	2.50
2.00	.55	1.00	4,314	766	5.63	1.53	1.50
2.00	.45	1.10	4,432	733	6.05	1.63	5.00
2.00	.50	1.10	3,975	773	5.14	1.67	5.50
2.00	.55	1.10	3,544	692	5.12	1.70	4.50
2.00	.45	1.20	3,861	690	5.60	1.80	7.00
2.00	.50	1.20	3,295	674	4.89	1.84	7.00
2.00	.55	1.20	3,061	675	4.53	1.88	6.50
2.50	.45	1.00	3,546	723	4.90	1.73	2.00
2.50	.50	1.00	3,760	696	5.40	1.81	1.50
2.50	.55	1.00	3,514	684	5.14	1.86	1.50
2.50	.45	1.10	3,235	694	4.66	1.92	5.00
2.50	.50	1.10	2,958	600	4.93	2.00	4.50
2.50	.55	1.10	2,946	605	4.87	2.06	5.00
2.50	.45	1.20	2,721	648	4.20	2.12	7.50
2.50	.50	1.20	2,105	529	3.98	2.21	7.50
2.50	.55	1.20	1,864	507	3.68	2.27	6.50
3.00	.45	1.00	2,951	620	4.76	2.06	1.00
3.00	.50	1.00	2,478	571	4.34	2.11	2.00
3.00	.55	1.00	2,776	581	4.78	2.17	2.00
3.00	.45	1.10	2,544	552	4.61	2.28	4.00
3.00	.50	1.10	2,011	492	4.09	2.35	4.50
3.00	.55	1.10	1,991	480	4.15	2.40	5.00
3.00	.45	1.20	1,807	490	3.69	2.48	6.50
3.00	.50	1.20	1,290	410	3.15	2.59	7.50
3.00	.55	1.20	1,353	384	3.52	2.66	7.00

[1]Each value is average of 6 cylinder breaks. [2]Each value is average of 6 beam breaks, 3 breaks on each of 2 beams. [3]By absolute volume.

cement ratio by absolute volume, and the slump. Figs. 1, 2, and 3 are drawn from data contained in the table. The same brand of cement and the same kind of fine and coarse aggregate were used in all mixtures. The fine aggregate was sand and the coarse aggregate was crushed limestone. All specimens were tested at the age of 28 days. Beams were tested as cantilevers.

In Fig. 1 the ratio of compressive to flexural strength for each of 27 different concrete mixtures is plotted as ordinate against the corresponding water-cement ratio as abscissa. The three values of b_s for each value of a/c and relative water content are joined by lines. The full line extending diagonally across the figure represents the average relation between the ratio of compressive to flexural strength and the water-cement ratio. It shows that the ratio of compressive to flexural strength decreases as the water-cement ratio increases.

In Fig. 2 the compressive strength of each mixture is plotted as ordinate against the corresponding flexural strength as abscissa. Lines join the three values of b_s as in Fig 1. The full diagonal line is established by the averages of the coordinates of the plotted points. This figure shows that for a decrease in compressive strength of about 68 per cent there is a corresponding decrease in flexural strentgh of about 44 per cent. In this particular test the water-cement ratio had less effect on the flexural strength than on the compressive strength.

Long Span Steel Arches Incorporate Sawtooth Roof

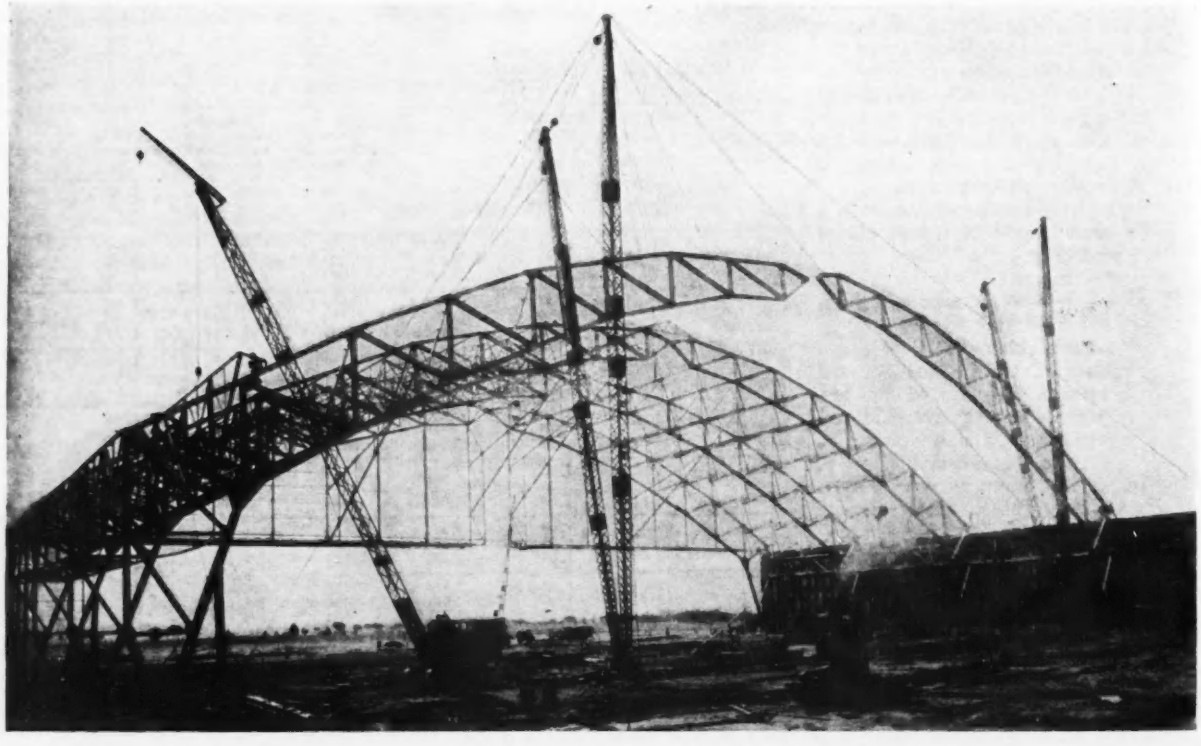
Unique design for airplane assembly plant in California assures adequate light over 285 x 296-ft. columnless area—Top chords of arches, left outside of building, are boxed in sheet metal housings.

EXPANSION of the Douglas Aircraft Co. at Santa Monica, Calif., undertaken last fall, called for providing some 350,000 sq.ft. of additional floor space for manufacturing purposes. Part of this, to be used as a final airplane assembly building, was located on a 285x296-ft. area at the east end of the existing row of buildings. Analysis of the problem suggested the advisability of housing this area so as to carry the roof on steel arches spanning the full width, thus eliminating all interior columns and giving a door opening to the flying field 250 ft. wide by 35 ft. high.

A roof design was worked out which gave uniform lighting and the other advantages of sawtooth roof panel construction in combination with three-hinged arch roof trusses. This was done by putting the sawtooth construction within the truss itself, leaving the top chord exposed. Six of the three-hinged arch trusses were used, spaced 48½ ft. apart. The street end of the building is closed with a framing of columns, struts, girts and corrugated iron siding. With a view to future extension at the opposite (flying field) end of the building, the arch truss over the doorway was made similar to the intermediate arches.

The shape of the arch framing is such that although the outside to outside width is 285 ft., the span between centers of the lower pins is 274 ft. 2 in. The arch truss members are all rolled beams, 12 in. wide varying in weight up to 120 lb. per foot, except for 10-in. beams used for members on one side of the center hinge pin and in one member at the lower pin where it was desir-

FIG. 1—ERECTING THE TRUSSES with 20-ton guy derricks. Crown pin connection made by rotating the ribs on lower pin by means of jacks set under wooden shores beneath the haunch.



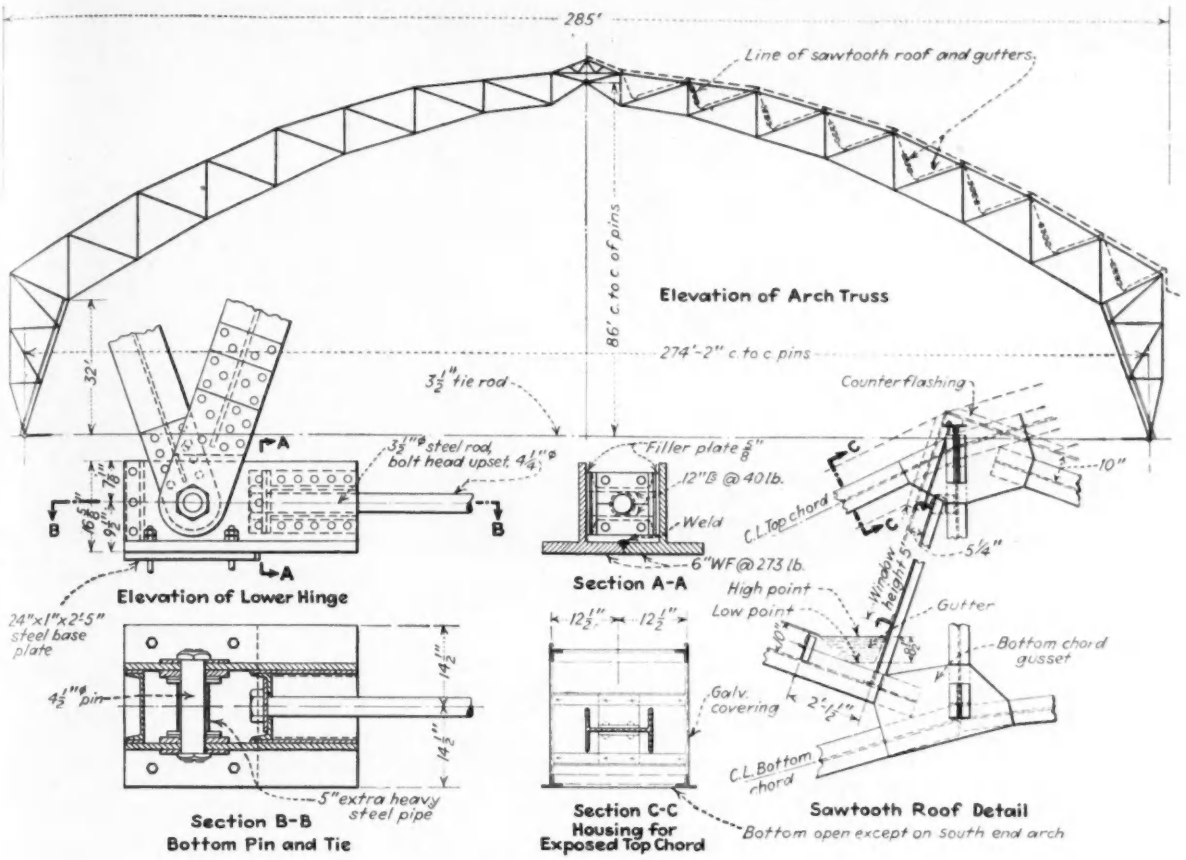


FIG. 2—STRUCTURAL DETAILS of new assembly building for Douglas Aircraft Co., at Santa Monica, Calif.

able to permit use of the beam flanges in pin bearing. Members are connected by double gusset plates riveted outside of the beam flanges, in addition to which bent plates are riveted to the webs at some of the joints.

In general, vertical web members of the arches are spaced 16 ft. 10 in. apart and the web diagonals are all on the same slope; in other words, are parallel (see Fig. 2). Within the angles thus formed by the web members a complete sawtooth roof is built up *below* the top chord of the arch. The top chords left exposed above the roofing are boxed in by sheet metal housings 25 in. square which form counter-flashings at the upper edge of each sawtooth bay and give to the general appearance of the building an effect resembling flying buttresses.

Transverse roof trusses are framed between arch web verticals, and the sawtooth roof slope is in the plane of the arch web diagonals. Intermediate roof beams are framed at the third point of the roof trusses, from the top chord joints to bottom chord joints of the adjacent roof truss next higher. The slope of continuous monitor windows in each sawtooth bay is normal to the roof slope, so that in each bay gutters are carried to the ends of the building through the arches without interference with gusset plates at the lower arch chord joints.

The thrust of each arch is carried across the building in the floor through a 3½-in. steel rod provided with upset threaded turnbuckle joints at splices, which were put in to get convenient shipping lengths. At either end the rod terminates in the lower hinge pin assembly through an upset screw, nut and plate, as shown in Fig. 2.

All framing, guides and canopy over the doorway are suspended from the end arch; a truss 10 ft. in depth in a horizontal plane is located directly above the clear door opening. At four intermediate points this truss is supported by cantilever frames which transmit wind load up to the roof bracing system. The closed end of the building is similarly braced to reduce the size and weight of the end wall columns.

Diagonal bracing is placed in all sawtooth bays in the plane of the sloping roof so that intermediate roof beams at third points between arch trusses act as members of the bracing system. Wind at the ends of the building and earthquake load is thus transmitted by zig-zag travel through each intermediate vertical sub-truss from the ridge to the eave, into eave sub-trusses 14 ft. deep, below which, in alternate bays, rod bracings (3 in. in diameter) carry down to welded plate bearings in concrete footings. The bottom chord of the eave sub-truss also is a chord of a horizontal truss equal in depth to the full width of the arch at that elevation and running the full building length.

The doorway is closed by sixteen sliding panels each 15 ft. 10 in. wide and 35 ft. high, operating on eight tracks. These panels nest outside the jambs without projecting beyond the corners of the building. The panels are riveted structural frames 6 in. thick covered with galvanized sheet metal and are equipped with ball bearing hangar door rollers. Three of the panels have pilot doors and each panel has about 180 sq.ft. of fixed steel window sash.

Erection methods

The steel arches were erected by two 20-ton guy derricks with 110-ft. masts aided by a crawler crane with a 90-ft. boom and a 10-ft. gaff. The haunch sections of each arch rib were set in place on the bases in pairs, where they were rotated 9 in. out of plumb in the direction away from the center of the building. The remainder of each arch rib, delivered to the job in three sections, was assembled and riveted into a single piece be-

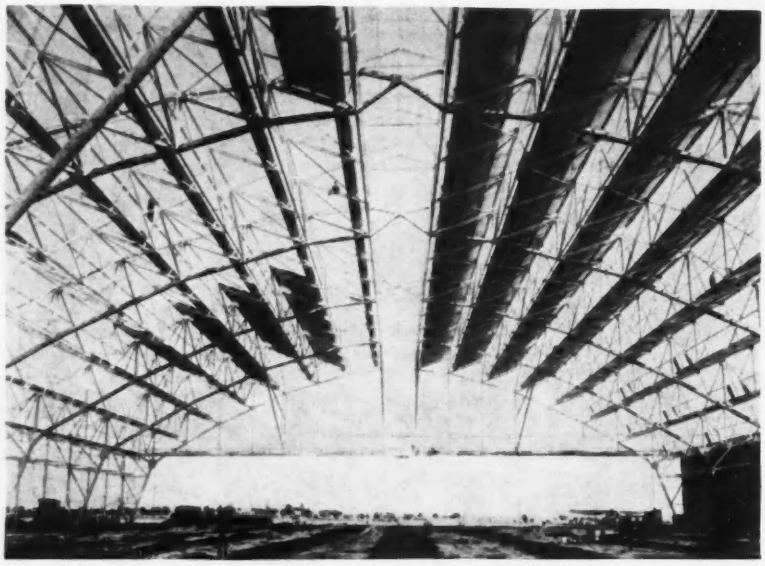


FIG. 1—SAWTOOTH roof being erected on a series of 274-ft. span trusses. The top chord, outside of the roof construction is housed against the weather. Note full width door opening.

fore raising. This assembly was checked for over-all length and shape by stretching a piano wire from the lower end to the crown pin hole and measuring ordinates from this wire to working points at lower chord joints. The rib sections then were raised in pairs and connections to the haunch sections were firmly pinned and bolted. The haunch sections were supported by shores on 25-ton jacks; the jacks were slacked off while the derricks lowered the ribs, to allow insertion of the crown pin.

The first arch thus erected was guyed by ⅞-in. cables, which were adjusted by turnbuckles to bring the arch to a vertical position. Then the derricks were moved back one bay and the operation was repeated. After setting the first arch the derricks remained connected to the ribs until the crawler crane had filled in sub-trusses, rafters and bracings sufficient to hold the arches in place. All window framing, girts, etc., were raised by an air hoist with runner line to the roof. Over the entire area all guy anchors, dead-men, etc., were so located as to permit derrick moves without changing the length of the guys.

Before erection of the superstructure the bases were set and the tie rods were put in, with turnbuckles pulled up, so that one line of bases was in the extreme position (toward the center of the building) permitted by slotted anchor holes. The effect was that the rods took all the horizontal thrust without shear on the anchor bolts. As the load was applied, the bases were moved out to insure putting stress into the rods without friction between bases and foundation.

The arch rib sections as raised by the derrick weighed about 16 tons each. Predetermined lengths of cable enabled the erector to hold the arch sections with the upper ends just high enough to clear and to permit final closure by lowering them in rotation about the lower pins. In detailing the structural steel, special provision was made to allow for deflections caused by dead load, particularly to adjust the elevation of door guides. Deflection of the arches closely approached the calculated change in shape.

Each arch truss weighed 43 tons and the total amount of metal in the completed steel frame structure, including the hangar doors, was 870 tons or about 20.6 lb. per sq.ft. of ground area covered.

Personnel

Donald W. Douglas, president, Douglas Aircraft Co., Inc., was in general charge of the plant additions which have been carried out under the direction of F. W. Conant of the Douglas organization. The structures were designed by the firm of Edward Cray Taylor and Ellis Wing Taylor, architects and engineers, Los Angeles, whose staff engaged on engineering and architectural design comprised Curt von Mueller, L. A. Ward, Stanley Gunderson and E. P. Rankin, Jr. S. B. Barnes, consulting structural engineer, participated in preliminary studies. Structural steel for the hangar was fabricated and erected by the Los Angeles shops of the Bethlehem Steel Co.

Clay in Suspension Decreases Scouring of River Bed

THAT CLEAR WATER in a swiftly-flowing river has a greater scouring effect on the sandy bed of the stream than muddy water is the conclusion of engineers at the National Bureau of Standards, Department of Commerce, who have studied this matter for a year in a miniature river constructed in the National Hydraulic Laboratory.

The particles of clay or silt carried in suspension tend to cement together the particles of sand which comprise the bed of the stream. In order to cause the same amount of scouring with muddy water as with clear water it was found necessary in the tests to make the muddy water flow from 10 to 25 per cent faster than the clear water, depending upon the coarseness of the sand of which the bed was composed.

This investigation, the results of which were published in the August number of the *Journal of Research* of the National Bureau of Standards, was undertaken at the request of the Bureau of Reclamation as part of its studies in connection with Boulder Dam. The Colorado River carries a tremendous load of fine sharp sand, and a great burden of still finer particles of clay or silt. The silt is so light and fine that it is carried along for miles without dropping to the bottom. Occasionally the amount of this silt becomes as much as 10 per cent of the total weight of the water. Meanwhile the fine sand of the river bed is dug up by eddy currents and is pushed along, remaining on the bed itself most of the time. The great dam has created a lake nearly 115 miles long above the dam which will serve as a stilling basin in which the river will first drop its load of sand, and then more gradually its load of suspended silt.

The problem that confronted the Bureau of Reclamation was: "What effect will the water, robbed of its protecting load of silt, have when it strikes the fine sand in the river bed below the dam? Is there reason to suppose that it may scour the river bed below the level established by the mud-laden stream that flowed there before the dam was built?"

This is the problem that the engineers of the National Bureau of Standards were asked to study in their laboratory where they had set up a sloping wooden flume 40 ft. long, 20 in. wide, and containing the model sand bed 8 ft. long made of sand obtained from the actual bed of the Colorado River.

An exact answer to the question is not possible under the present state of hydraulic knowledge, but the results of this investigation indicate that a greater scouring away of the sand bed may be expected in the Colorado River when clear water flows over its bed than was the case with the original muddy river.

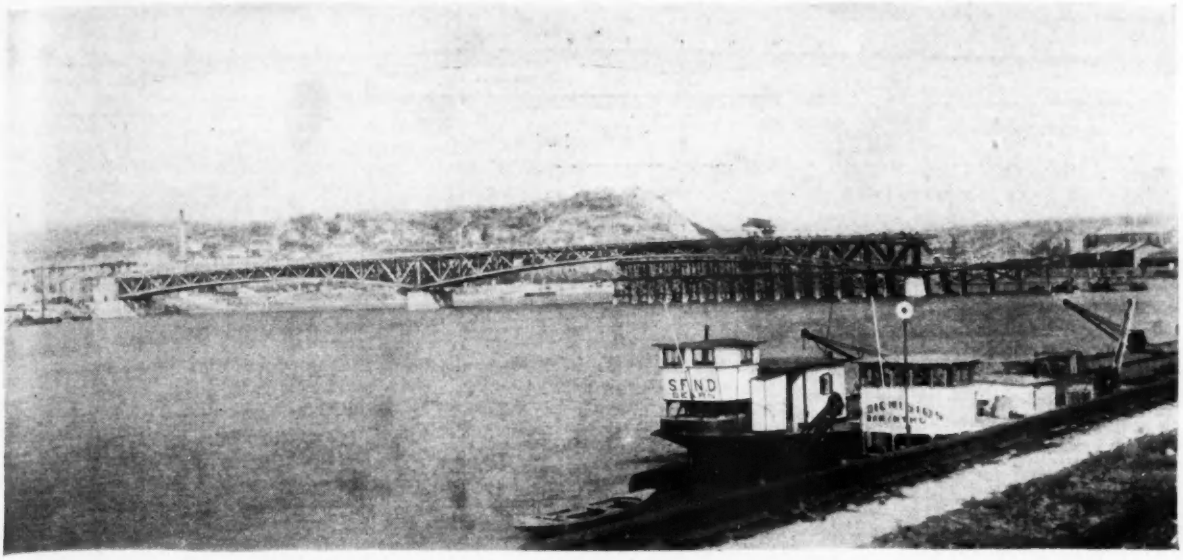


FIG. 1—THE HORTHY MIKLOS BRIDGE at Budapest is notable for its small rise-span ratio. Aesthetic considerations called for a low bridge but navigation requirements made a fairly high underclearance necessary over the main channel.

Shallow Continuous Trusses For Budapest Bridge

New crossing of Danube contains a center span of 500 ft. whose center depth is only 13 ft.—Four trusses carry 51-ft. roadway

By F. L. Ehasz
Instructor in Civil Engineering, Lehigh University, Bethlehem, Pa.

A NEW HIGHWAY BRIDGE of bold proportions is under construction over the Danube River in Budapest, Hungary. Known as the Horthy Miklos Bridge in commemoration of the tenth anniversary of rule of the Regent of Hungary, the new structure consists of three continuous spans, the center span of 500 ft. having the unusually small rise-span ratio of 1:38. The location of the new structure is shown in Fig. 2 in relation to the two railroad and four highway bridges that now cross the Danube at Budapest. The new bridge provides a continuation of the busiest street of the city and will relieve congestion on the Ferenc Jozsef bridge, immediately upstream.

The Horthy Miklos bridge is of continuous Warren deck-truss type with verticals and curved lower chords. This type was selected because the architecture of the buildings on the Pest bank will undoubtedly have a better effect with an unobstructed view. The suspension-type was considered and rejected after a careful economic comparison indicated a superiority for the continuous bridge. Furthermore, a deck structure suits the surroundings because of the level country on both sides of the Danube at this point. The Warren webbing is desirable for alternating stresses. Graceful appearance and shop economy are achieved by the symmetry of design.

The theoretical depth of the 500-ft. central span is 13 ft. or about 1/38 of the length. This small ratio makes the structure audacious and interesting. Hitherto, bridges with small ratios have been built in Europe, especially in Germany, but not for such long spans as those of the Horthy Miklos Bridge. Another variation from common practice may be found in the shape of the lower chord, which is usually straight and has elbows only near the piers. This structure has curved lower chords, to satisfy navigation requirements and at the same time to minimize the height of the roadway, thereby reducing the cost of embankment on the Buda shore.

Deflection under capacity loading is comparatively large because of the shallow truss depth, being about 1/600 of the span. This is not unsafe, however, because there are four main trusses which are rarely loaded to capacity simultaneously. The steel of which the bridge is being built has an elastic limit of 34,200 lb. per sq.in. and an ultimate strength of 51,000-64,000 lb. per sq.in. It has a prescribed elongation of 20-27 per cent and the allowable stress is 20,000 lb. per sq.in. This soft grade of steel is advantageous for the structure because members of large cross-section, which are favorable for the deflection, are necessary. Besides, in Hungary, where consumption of steel is small, more elastic material is so expensive that its use is seldom economical even for large spans.

The bridge will carry two trolley tracks in the middle section of the roadway and four vehicular lanes. Sidewalks, 11½ ft. wide, flank the outer vehicular lanes on both sides of the bridge. The construction shown in Fig. 4 is eco-

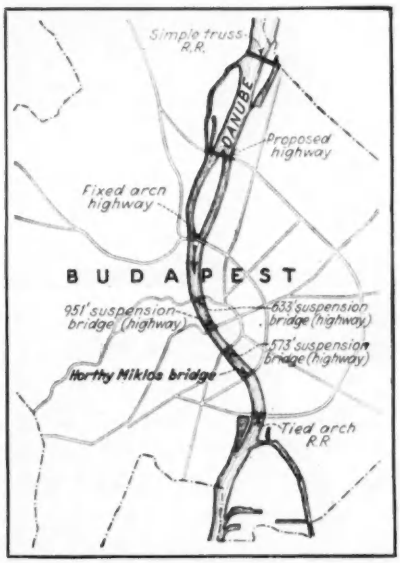


FIG. 2—THE BRIDGES of Budapest showing the location of the new Horthy Miklos crossing

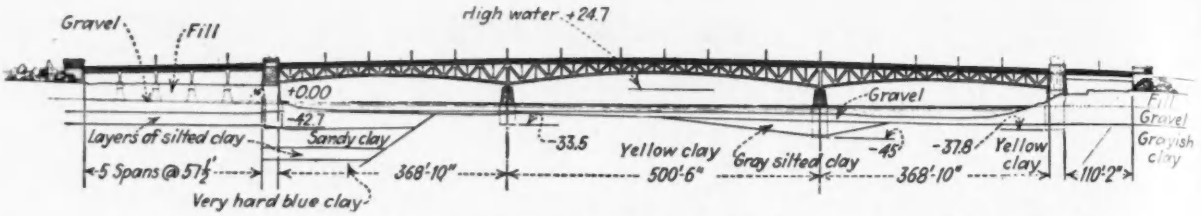


FIG. 3—SHALLOW continuous truss bridge under construction over the Danube River in Budapest, Hungary. Rise-span ratio of 500 ft. center span is only 1:38.

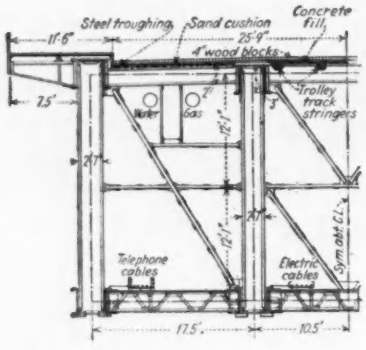


FIG. 4—FOUR TRUSSES with substantial sway bracing comprise the main structure. The deck consists of concrete-filled steel troughs and wood blocks.

nomical in spite of the shallow depth because heavy floorbeams are avoided. The floor is carried by 17- and 21-ft. span cross-beams, spaced 4 to 6 ft. apart. Advantageous load distribution and rigidity are secured by upper and lower chord braces and by swaybraces at all vertical members.

Foundation problems were not difficult, pneumatic caissons, about 100 ft. long and 30 ft. wide, being employed in the building of the piers. In the preliminary investigation of soil conditions on the Buda shore, a sulphate content of 300-400 milligrams per liter was found in the ground water. Protective measures applied to the substructure are provided by two layers of bitumen and a 4-in. coating of bauxite which covers the waterproofing. The rest of the substructure consists of concrete with trass as admixture, to make a denser and more economical mix.

The expenses of the project are being met partly by state funds and partly by the income of a 1.25 per cent additional fee on all real estate transactions. Foundations are complete and one span is erected, so that completion is expected next year.

This project is being carried out by the bridge department of the Hungarian department of public works. In 1930 a competition was held with the plan of adopting the design of the winner. After the competition, however, the governing conditions were changed somewhat, and another design prepared by the staff of the bridge department was adopted. P. Algay-Hubert, consulting engineer for the state government, is the chief designing engineer.

Better Mixer Charging Control Improves Quality of Concrete

Higher average strength, fewer erratics and greatly increased uniformity of product result from studies of charging procedure still under way at Grand Coulee Dam

NOTABLE IMPROVEMENT in the quality of concrete has been effected as the result of a series of studies on mixer charging procedure at Grand Coulee Dam. Instead of visual inspection, the usual method of judging mix quality, job samples are taken from different parts of the mixer and water/cement and sand/cement ratios in each sample are reduced to an "efficiency factor." Thus a very accurate basis was available for comparing results when methods and even the equipment were varied to improve conditions. Certain fundamentals as to the proper methods of charging were worked out in the process of developing what amounts to a new technique in concrete mixer charging. Operation under the methods that grew out of these studies has resulted in producing a concrete which uniformly shows a mixer efficiency factor exceeding 90 per cent. This is a definitely established index of the effectiveness of the mixing which, it is believed, easily might fall as low as 70 per cent in the absence of accurate determinations and under the old method of depending upon visual inspection. Higher average strengths and a lower percentage of erratics have been obtained than are believed to be feasible without the improvements in charging procedure and control described in the following.

Although the results obtained to date are rated as tentative and experimental, such excellent progress has been made that a very definite technique in charging the mixer has been established and is producing concrete of a highly satisfactory quality and will be continued as now in use unless continuation of the studies brings out means of still further improvement. The arrangement of the mixing plant at Grand Coulee Dam was described in *ENR*, Jan. 23, 1936, p. 119.

Close observation of mixer operation in the early stages of the Grand Coulee work indicated that relatively long periods of mixing were required to obtain a high quality product. It was then determined to make a series of experiments in the operations of charging and mixing. To carry these on effectively some exact method of comparison was required. Accordingly, samples were taken from three different locations in the mixer (front, center and back) for different mixing periods and with different methods of charging.

The mortar from these samples was analyzed for sand/cement and water/cement ratios and the leanest in sand or water in each group of three was rated as 100 per cent; the other two were given a correspondingly higher percentage in accordance with their contents. A sample that showed not more than a 10 per cent variation from the leanest of the three was rated as *A*, less than 15 was rated as *B* and less than 20 was rated as *C*. One-third the sum of the percentages of all batches tested which were rated as *A*, *B* and *C* was used as the efficiency factor for the group. (These low variations were obtained only after much experiment.) The combined efficiency factors for sand/cement and water/cement ratios was used as the efficiency factor for the mix. Of these two ratios it is to be noted that the water/cement is more important in terms of strength and that the sand/

cement is of importance primarily from the workability standpoint.

Using these methods of determination the specified mixing time in the month of February, when the concrete studies began, gave only a 47 per cent efficiency factor (this low figure may have been the result of a combination of charging procedure and other unregulated factors), in March 76 per cent, April 74 per cent, May, 73 per cent. At this point the blades in the mixer were modified with the resultant immediate increase in the efficiency factor to 89 per cent. In the month of June it was 92 per cent and since then has been maintained in excess of 90 per cent most of the time.

From the foregoing it is not to be assumed that the lower quality concrete mixes went into the dam. The figures given are for the specified mixing time which permits of a 3-min. complete cycle in the mixer operation. During these periods of low efficiency factors the mixing was continued long enough after taking the samples, to obtain the quality of mix required; this was as long as 15 min. in some cases. By the time all the improvements had been put into effect the desired results could be obtained in even less than the specified 2½-min. mixing time.

Test samples

At the outset the samples were obtained by stopping the mixer and having a man crawl inside to take the samples at the specified locations within the mixer. After the improvement in mixing it was found that it was satisfactory to take samples from the stream of material being dumped from the mixer. The samples are about 1,000 gram size and are taken at different times during the discharge. The samples are weighed in air and in water, washed through a 100-mesh screen and the rejects reweighed in water. In the specified standard mix the sand-cement ratio runs 1:2.7 Five per cent of the sand may pass through a 100-mesh screen.

An unusual feature of materials used on this job is that samples containing silt gave higher strength than did test specimens made with clean aggregates. In other words, the percentages of silt that sometimes may have a very bad effect, in this case gave an increase in strength at some ages. It was thought that this might be caused by some puzzolanic effect or perhaps by cutting down the water-cement ratio. About 1½ per cent of the sand used in the Grand Coulee mix will pass through the 200-mesh screen. Specifications call for the fineness modulus of the sand to be between 2.50 and 3.00. The materials plant is constructed in such a way that the fineness modulus is maintained between 2.65 and 2.85.

At the start of the investigation samples taken from front, center and back of the mixer sometimes varied by 400 or 500 per cent. Even visual inspection showed the incomplete nature of the mix and it was under these conditions that mixing was continued in some instances as long as 15 min. This long period of mixing required to get results was ascribed to segregation of material in different locations or zones in the mixer. This zoning, in turn, appeared to be the result of the sequence in the admission of materials as used at the outset. For example, under certain conditions there was a very decided tendency for an excess of sand to lodge at the front of the mixer. The changes in the procedure were designed to compensate for these tendencies.

Charging procedure

The substance of conclusions resulting from the tests and observations is that proper charging procedure involves the following sequence: Water should go into the empty mixer first in quantity up to 10 or 15 per cent of the total water charge. The admission of water should continue uniformly all through the charging period with about 10 per cent following the last of the aggregate. This sequence facilitates the flow of material in the mixer, and clears out anything that otherwise might lodge in the throat of the mixer from the last of the charging process. After the initial water admission, sand and cement should be admitted together and at a constant rate throughout the period required to complete the charge of sand and cement. If the rate of admission of either sand or cement is to vary, the variation should be the same for both these ingredients, thus making sure that they enter in the same proportions throughout the period of their admission. The coarse aggregate should not start until at least a second or two after the sand and cement flow has started. As a practical matter the coarse aggregate goes in less uniformly than the sand, cement and water but this is unimportant so long as a part of the sand and cement charge has gone in first.

After these fundamentals were determined, the desired rate of admission was set on the automatic controls. Thus the predetermined rates of admission are automatically accomplished when the batch operator pushes the control buttons that combine ingredients in any of the five standard proportions.

On the installation at Grand Coulee the consistency meters similar to those developed for Boulder Dam are installed. These are indicators which record power variations required to rotate the mixers, and can be interpreted to indicate changes of slump. They are, in principle, recording wattmeters on the motors which turn the mixer. The underlying principle is that the power required for turning the mixer varies with the water content of the mix. Under conditions of operation at Grand Coulee and in accordance with specifications, the slump very closely follows the 2½-in. line. If the moisture content in the sand changes, the quantity of water per batch is changed to correspond. Ordinarily a 1-in. slump change will correspond to a change of about 40 lb. of water per 4-yard batch.

Tests of the finished product

Specifications call for a concrete strength of 3,800 lb. after 28 days in 6x12-in. cylinders made after removing the heavy aggregate by wet screening, or 2,900 lb. for mass concrete in 24x48-in. cylinders. The concrete has been running about 5,200 lb. in 28 days. With these high-strength results and high uniformity made possible by effective mixing, it has been suggested that there would be less hazard than otherwise in cutting down the cement content somewhat.

Grand Coulee Dam is being constructed for the U. S. Bureau of Reclamation, R. F. Walter, Denver, chief engineer; F. A. Banks, construction engineer, Grand Coulee project; O. G. Patch is concrete technician. Contract for the construction is being carried out by the M.W.A.K. Co.; George H. Atkinson, general manager, C. D. Riddle, chief engineer.

Construction's Place In the WPA Program

ON THE first of September the Works Progress Administration had completed or had under way 59,000 construction projects. These construction projects represent more than half of the total of all projects on the WPA program. Structures which were built, repaired, or improved under WPA projects include 6,200 school buildings, 130,000 miles of road, 5,000 water systems, 2,200 water conservation and irrigation structures, and 550 airports. A tabulation is given below of the number and cost of construction projects of different types. The costs given include materials purchased by sponsors of projects and rental of hired equipment. The cost does not include any allowance for equipment owned and furnished by the sponsors.

WPA CONSTRUCTION PROJECTS

Classification	No. of projects	Cost of project
Roads and streets	27,774	$45,952,000
Public buildings	13,325	27,297,000
Parks, etc.	5,772	20,601,000
Conservation	3,783	6,817,000
Waterworks and sewers	8,413	24,065,000
Airports	713	4,156,000
Unclassified		13,112,000
Total		142,000,000

The 2,063,000 men employed on construction projects represent more than two-thirds of the 2,952,000 men employed by the works program of the WPA. Of those employed on construction projects, 1,761,000 were unskilled workers; 16,000 were engineers; the remainder were in clerical and supervising positions.

CURRENT HIGHWAY PROBLEMS—III

Writing a Highway Constitution

Procedure followed in preparing a fundamental road-improvement plan for New York state

By Roy G. Finch
Executive Engineer, New York State Highway Survey Committee, Albany, N. Y.

FOR A NUMBER OF YEARS, *consciousness of the need of established constitutions for highway government has been increasing. Now action is being taken. All but half a score of state highway departments cooperating with the federal Bureau of Public Roads are making highway inventories and economic traffic surveys as a basis for systematic planning of road improvement and operation. New York state, independent of the present general program has progressed a step further and formulated a fundamental law of action—the first state highway constitution. As a criterion for definite planning by other states as their inventories and surveys are completed, the procedure and course of reasoning in developing the New York plan has suggestive value and a definite place in this series of discussions of current highway problems. Authority has been put behind the publication by securing as the author the engineer under whose technical direction the extensive accumulation of data was obtained and the results analyzed and coordinated into a formal plan for legislative action. A narrative of creative work of exceptional interest and value is presented in the pages that follow.* —EDITOR.

THE need for adopting a comprehensive highway policy extending over a reasonable period of years with a method of financing, has long been apparent in many states. Highway construction has not kept pace with the development of the automotive industry and motor vehicle transportation. The day is gone when the highway engineer may endeavor to dictate, through highway design, the number of motor vehicles that may pass over the highways or the speeds at which they may travel. The public demands automobiles equipped to furnish speedy transportation and the manufacturer has responded to this demand. Within reasonable limits, it is the function of the highway engineer to provide the roadbed over which this ever increasing number of fast motor vehicles may travel in comfort and in safety, and this can never be accomplished in a satisfactory manner until a fundamental plan for highway construction that looks well into the future, and a method for financing such a plan, have been adopted.

A plan undertaken

In New York state there was created in 1934 by joint resolution of the legislature, the State Highway Survey Committee. On this committee were members from both the Senate and Assembly, the Superintendent of Public Works, the Commissioner of Highways and three citizens of the state representing respectively agricultural interests, cities and automobile owners. Senator George R. Fearon is chairman of the committee. The purpose of this committee, as set forth in the resolution creating it, was to make a state-wide survey of road and traffic conditions with respect to the construction of streets and highways and to ascertain the facts with regard to volume, character and distribution of traffic. It was also directed to make an economic survey to reveal sources of highway revenues to the end that highway construction both rural and urban, might be considered in accordance with the facts, and funds equitably distributed. In brief, this committee was directed to assemble the data and ascertain the facts to make it possible for the legislature to determine a sound future highway policy embracing a rational program and a method of financing it.

Mileage and financing checked

In approaching the problem, it was necessary to ascertain first the mileage of the highways, roads and streets in the state and to know something about the appropriations which had been made by the state, and the apportionment of federal funds made available for highway purposes over a period of years. This information is summarized in Tables I and II. With these recorded data special surveys and inventories were undertaken.

A determination of the amount of work performed or service rendered by the various highways was obtained from a traffic census. Over 1,000 counting stations were established on the state system of highways and the count taken for varying periods in the months of February, June, August and November. At the most important stations, traffic was counted for a continuous period of one week. About 74 per cent of the counties and 26 per cent of the cities cooperated in taking traffic counts at the same time on their respective systems of highways and streets.

Through the cooperation of the Bureau of Public Roads a road use and financial survey was made. A total of 25,000 motor car and truck owners so selected as to be representative of all those in the state, were interviewed and the results of these interviews gave a picture of the driving habits of the motor-vehicle owners of the state and the proportionate use made by the residents of the various governmental units of the various systems of highways. The financial survey disclosed the total expenditures of the governmental units for highways, education, public benefits, and government, and how much was expended locally for each purpose and how much by the state and county in each of the units. Generally speaking, so far as highways are concerned, the financial survey reveals the source and flow of funds for highway purposes.

Unimproved roads surveyed

A survey was made of the unimproved mileage on both the state and county systems of highways and also the extent of the reconstruction which should be undertaken on both systems over a reasonable period of time and the estimated cost of performing such work. A physical inspection was made of the more than 50,000 miles of town highways which were classified in the order of their importance for future improvement. A study was made of the need of arterial and bypass highways in cities to relieve congestion caused to a large extent by through traffic superimposed on the local traffic.

With the factual information developed from these surveys and studies, the data were available on which a com-

TABLE I—SOURCES OF MONEY AND ANNUAL EXPENDITURES ON NEW YORK HIGHWAYS

YEAR	State and county highways	Maintenance and repairs of highways	—Federal Rural Post Roads— State	Federal government aid and emergency grants	Grade crossing bond issue sold	Highway bridges	Large bridges (Special)	Special Appropriation including Long Island Parkways	State aid to counties	State aid to towns	Total
1922	$239,274	$6,150,000	$6,750,000	$6,204,042	.....	.....	.....	$28,000	$2,251,285	$2,392,822	.....
1923	3,000,000	9,000,000	5,000,000	4,928,597	.....	.....	200,000	625,000	2,365,680	2,489,500	.....
1924	3,000,000	12,000,000	5,000,000	3,251,515	.....	.....	450,000	.....	2,336,475	2,547,044	.....
1925	3,000,000	14,650,000	8,000,000	3,663,105	.....	.....	.....	35,000	2,416,243	2,620,326	.....
1926	3,000,000	16,500,000	6,000,000	3,689,881	.....	.....	2,200,000	1,133,000	2,400,170	2,711,260	.....
1927	3,000,000	18,000,000	6,000,000	3,647,604	.....	$3,000,000	3,225,000	2,980,000	2,400,070	2,908,760	.....
1928	4,000,000	20,000,000	7,000,000	3,635,217	No details	3,000,000	200,000	4,825,000	2,376,390	3,098,077	.....
1929	9,400,000	20,550,000	7,000,000	3,629,879	.....	3,000,000	2,500,000	6,104,900	2,392,200	3,348,180	.....
1930	9,400,000	22,550,000	7,000,000	3,617,748	.....	6,154,000	.....	2,845,200	2,104,240	3,448,146	.....
1931	.....	17,000,000	23,250,566	16,079,080	.....	6,000,000	3,000,000	1,345,000	2,106,147	4,021,599	.....
1932	1,612,000	13,000,000	12,059,238	11,401,744	.....	2,500,000	1,300,000	1,865,000	1,987,692	4,440,085	.....
1933	5,000,000	7,990,000	.....	22,330,101	.....	.....	.....	1,826,214	76,161	3,748,206	.....
1934	5,000,000	11,000,000	.....	11,327,921	.....	.....	.....	1,800,000	1,692,720	3,324,260	.....
1935	7,050,000	9,000,000	6,150,000	30,773,672	.....	.....	.....	1,983,955	2,012,000	3,300,000	.....
Totals	$56,701,274	$197,390,000	$99,209,804	$128,180,109	$77,500,000	$23,654,000	$13,075,000	$27,396,269	$28,917,473	$44,398,265	$696,422,195
									Deduct "Federal government aid and emergency grants"		128,180,109
									Appropriated by state, 14-year period (1922-1935, inclusive)		$568,242,086

prehensive highway program could be based.

New York State has never had a highway program where the needs could be determined in advance and with reasonable assurance of performing the work. The variations in the amounts of the appropriations made available during the past 14 years shows that a stable program could not be established. These amounts vary in different years from a minimum of $24,000,000 to a maximum of nearly $84,000,000. Highway officials could not plan with any degree of certainty, even one or two years in advance what might be accomplished, as the amount of money to be made available was never determined until the close of the legislative session.

Planned construction necessary

It is quite obvious that, if highway construction is to keep pace with the demands of traffic, planned construction over a reasonable period of years must be established in advance and funds in definite amounts must be made available each year to execute the predetermined program. Until a comprehensive program has been adopted, there can be no assurance of a steady flow of funds and without assurance of funds a program cannot be established. They are inseparable, the one depending on the other, and must be worked out concurrently.

Finances determined

From the general study of the situation in New York state, the committee determined that $92,000,000 a year for a highway program extending over five years was an amount which the state should spend. The committee also was of the opinion that those who used the highways—the motorists—should finance the program by fuel and registration taxes. It was considered that there would be but little if any complaint from the motorist on the imposition of these taxes, even though they do add substantially to the cost of operating a motor vehicle, providing all the funds were used for the purpose for which they were collected—namely, highway improvements. The diversion for governmental purposes other than highways and thus the levying of a sales tax on one particular group of citizens is what the motorist objects to, and rightfully so. At the present time in New York state there is a 3c. per gallon state fuel tax, and 2c. from this tax is supposed to be used exclusively for highways. The remaining 1c., which is an emergency tax and is so designated, can be used for any general state purpose.

TABLE II—MILEAGE OF PUBLIC ROADS IN NEW YORK

Classification	Improved Miles	Unimproved Miles	Total Miles
State Highway System	12,453	1,109	13,562
County Road System	13,145	4,521	17,666
Town Highway System	20,609	32,156	52,765
City Streets	6,986	3,727	10,713
Village Streets	3,212	2,323	5,535
Totals	56,405	43,836	100,241

Anticipated tax income

From a study of the registration figures of motor vehicles in the state and the receipts from the registration fees and fuel taxes, it is estimated that with a 3c. fuel tax and a continuance of registration fees in their present amounts, the total net receipts for the average year during the next five-year period will amount to at least $88,000,000. During the past few years, the aid received from the federal government and emergency grants applicable for highway purposes have been in substantial amounts. In setting up anticipated revenues only $6,150,000 was used as coming from this source. This is regular federal aid received by the state for highway purposes, which may reasonably be expected will be available annually. This makes a total anticipated annual revenue available for highway purposes of $94,150,000 which is more than $2,000,000 in excess of the yearly expenditures necessary to finance the comprehensive highway program recommended by the committee.

Having determined as to the source from which funds could be obtained and the amount in which it could be reasonably assumed that such funds could be made available yearly, the next step was to allocate such a sum among the various systems of highways and between the various governmental units in an equitable manner and to meet the needs as disclosed by the study made by the committee.

State roads

The state system, embracing some 12,453 mi. of improved and 1,109 mi. of unimproved highways on which the sole expense of construction and reconstruction is borne by the state, was first considered in the allocation of funds. A sum of $9,000,000 a year or an average of slightly over $700 per mile was allowed for maintenance. Past experience has shown that it requires this amount per year properly to maintain the state system. On the basis of a five-year program a study was made to determine the mileage whose condition is, or will become such during the period, as to require reconstruction. The study disclosed the probable necessity for the reconstruction of a total of 5,230 mi. of highway at an estimated annual cost of $22,700,000. During the period in which such reconstruction is progressing, the construction and reconstruction of bridges on the state system should also be progressed, and an allotment of $3,000,000 per year for this purpose was made. Both these are recurring items of expense which must always be considered in any comprehensive highway program to provide for rebuilding highways and bridges which have worn out and need improvement to meet adequately the demands of traffic.

Under existing provisions of the highway law, the rights-of-way necessary in the reconstruction of the state system, are acquired by and at the expense of the

county. This is unsound in many respects. Delays occur in placing work under contract and in some instances the improvement of parts of important through-routes cannot be advanced due to the failure of the counties to secure the right-of-way. Reconstruction on the main routes is primarily to meet the needs of through traffic and the acquisition of relatively small amounts of land along developed frontages is expensive and, in effect, the counties are asked to acquire property for the second time for the same highway. The cost of acquiring rights-of-way is just as much a part of the general construction as the pavement itself. The committee recommended that this be recognized and alloted $1,900,000 per year over the five-year period for rights-of-way expense. In the recommended yearly program the sum of $27,500,000 was allocated to the reconstruction on the state system.

The highways on the state system include the heavily-travelled routes over which reasonable and safe transportation facilities must be assured at all times of the year which calls for snow removal and sanding during the winter months. At present, snow removal is generally carried on by the counties with partial reimbursement from the state for the expense incurred, while sanding is done by the state at state expense. These two activities should be coordinated under the general supervision of the state, and the committee so recommended and allotted $1,500,000 per year for this work.

Completion of state system

On the state system, 1,109 mi. remain unimproved. As the result of the study, it was estimated that the average cost per mile to build this unimproved mileage, including rights-of-way, would be $43,600. It was recommended that the completion of this mileage on the state system be spread over an 8-year period and $6,000,000 per year be allotted for such construction. During this same period an allotment of $4,000,000 per year was recommended for the extension of the state parkway system outside of cities. This makes an annual appropriation of $10,000,000 for the completion of the state system and parkway extensions.

State system appropriation

The total annual recommended appropriation for use on the state system as above analyzed amounts to $48,000,000. While it is true that this system accounts for only 14 per cent of the total highway mileage in the state, the study showed that about 45 per cent of the total yearly travel on all highways, roads and streets occurred on the state system. This proposed allotment of $48,000,000 per year for the state system out of a total annual expenditure of $92,000,000 seems to be equitable and it appears to meet the needs of, and to conform very closely to the actual use made of this system in relation to the total travel on all systems.

County road system

The county road system, which includes all roads constructed and maintained at county expense, was next considered. The total mileage on the system is 17,666, which is some 4,000 miles in excess of that on the state system. Of this county mileage, 13,145 mi. have been improved and 4,521 mi. remain unimproved. The state now aids the various counties in meeting highway expenditures by a contribution equal in amount to that raised by each county by tax for highway purposes and through a refund of a portion of the motor registration fees and fuel taxes. It is estimated that the total amount coming to the counties from these sources will average $14,000,000 per year over the next five year period. The committee recommended that this aid be continued, which would probably make possible the improvement of the present unimproved mileage on the county system within the next 7 to 10 years. The study disclosed that since the inception of the county road system over 20 years ago, the counties have endeavored to construct a large mileage and thus serve the greatest number of people.

The county road system comprises 18 per cent of the total state mileage but carries only about 6 per cent of the total state traffic. These county roads serve in a large measure as feeders to the highways on the state system and in many instances parallel these more heavily traveled routes; their greater use, if only to relieve congestion on the main routes, should be encouraged. It was determined that throughout the state some 6,540 mi. of improved roads on the county system need reconstruction in varying degrees. With the present burden on the counties of maintaining over 13,000 mi. of roads, and providing for the improvement of over 4,500 mi. of unimproved roads scheduled for improvement, very little progress can be expected in the reconstruction of roads. To stimulate this reconstruction and provide adequate and safe facilities over which traffic may move, the committee recommended additional state aid to counties in the amount of $3,000,000 per year to be available only for the reconstruction of roads on the county system. The total recommended appropriations for the counties on the yearly highway program advanced by the committee amounts to $17,000,000.

Township highways

The town highway system comprises all highways outside of cities and incorporated villages which are not included on either the state or county systems and embrace 52,765 mi. of which 20,609 mi. have been improved in varying degrees and 32,156 mi. remain unimproved. At the present time state aid to towns for highway purposes amounts to about $3,000,000 per year. The committee recommended that this aid be continued. A physical inspection was made of the more than 50,000 miles of town highways and from the results of this inspection each highway was placed in one of the following five classifications:

1. Those at present improved, which improvement may be considered adequate for modern roads—16,262 mi.
2. Desirable farm-to-market roads which should be improved at a cost ranging from $4,000 to $8,000 per mile—2,892 mi.
3. Those that should be drained and reasonably graded to provide satisfactory service a large portion of the year at an estimated cost of about $2,000 per mile. This group may more properly be designated as "problem roads,"—22,026 mi.
4. Roads which may eventually be closed, if and when land may be reforested. Pending reforestation, they must be kept reasonably passable under existing conditions—5,490 mi.
5. Roads that are unused or should be abandoned—4,298 mi.

The study disclosed that the mileage in Class 1 served areas definitely devoted to agriculture and this mileage should be considered and maintained as improved highways. The mileage in Classes 4 and 5 serves areas which have been or should be abandoned for agricultural purposes and devoted to reforestation and recreational uses. Expenditures for highways in these two classes should be kept to the minimum. There remained the Class 2 group which it was felt should be improved as farm-to-market roads, and the Class 3 or problem group on which only a nominal expenditure should be made.

Farm service roads

From the standpoint of the volume of traffic on these town highways in Classes 2 and 3 as compared with the traffic carried on the state or county systems, only a small expenditure for highway improvements could be justified. There is, however, another very important factor which must be considered—these highways are in rural sections of the state not financially able to undertake highway improvements to any great extent. It is in the interest of all the people of the state that the farmer living in these remote areas be served with a passable road over which he may travel in bringing his products to the consuming public. Any comprehensive highway plan which does not consider this factor and make provision for meeting the situation reasonably is faulty. The committee recommended an appropriation of $4,000,000 per year for improvements to town highways falling within classifications 2 and 3.

The total recommended appropriations

for town highways on the yearly highway program advanced by the committee amounts to $7,000,000.

Highways through cities

The situation controlling in the cities outside of New York City was next considered by the committee. At the present time these up-state cities receive no refund from motor vehicle registration fees or fuel taxes which might be used for street and highway purposes. Within the limits of incorporated villages, highways (actually village streets) that in fact form a part of a through route on either the state or county system, can be consructed at state or county expense. In cities, however, such funds cannot be expended for highway construction even though certain city streets do constitute parts of through routes. Traffic congestion on these routes in cities must be relieved either by the building of arterial or bypass highways.

The study disclosed that nearly 20 per cent of the traffic on the state system, which to a very great extent can be considered as through traffic, occurred on streets entirely financed by the municipalities themselves. From the results of a survey made as to the needs of arterial and bypass highways in up-state cities it was felt that during a five-year period $35,000,000 should be spent for this work. The committee recommended an appropriation of $7,000,000 per year over a five-year period for such purpose, the work to be performed under the direction of the state and the cities to provide the necessary rights-of-way and on completion to assume the cost of maintenance.

In view of the fact that these up-state cities for many years have constructed and maintained streets which were parts of heavily traveled main routes and for which they have received no aid from the state, and that now they will be called upon to provide rights-of way and assume the maintenance of the proposed bypass and arterial highways, the committee concluded that such cities were entitled to a direct contribution in the form of state aid for general street and highway purposes. The committee recommended that $3,000,000 per year be given to the cities for such purposes to be distributed on the basis of population.

The total recommended appropriations for cities outside of New York City on the yearly highway program advanced by the committee amounts to $10,000,000.

The residents of New York City pay 60 per cent of the total tax of the state. They pay 39 per cent of the motor vehicle registration fees and over 43 per cent of the motor fuel taxes. There is, however, returned to New York City about $6,000,000 per year from the motor vehicle registration fees and fuel taxes and since 1916 this refund has amounted to over $58,000,000. Residents of up-state cities having a population of over 75,000 pay 17 per cent of the motor vehicle registration fees and fuel taxes and the streets of up-state cities carry nearly three times the amount of through traffic carried by New York City streets. The up-state cities have never received any refund from the motor vehicle registration fees and fuel taxes. The committee recognized, however, that New York City also faces a problem in the construction of arterial and bypass highways and recommended the continuation of the payment of the present refund from the motor vehicle fees and taxes and that New York City be granted additional state aid of $4,000,000 per year to be used for the construction and reconstruction of arterial and bypass highways. The total recommended appropriations for New York City on the yearly highway program advanced by the committee amounts to $10,000,000.

From its very intensive study and from the facts developed from the many surveys and investigations, the Committee recommended this yearly highway program, to be financed from the proceeds of the 3-cent fuel tax and present registration fees, both to be used exclusively for highway purposes.

Safety not overlooked

Highway safety was not overlooked by the committee in the consideration of its problem. When it is realized that during the past ten years accidents on New York state highways have resulted in 29,000 deaths and nearly 1,100,000 injuries which, on the basis adopted by insurance companies represents a loss of three billion dollars, it brings home the gravity of the highway safety problem. Accidents on highways never can be entirely eliminated regardless of the amount expended on highway construction, but highways can be built that will reduce greatly the probability of accidents. The state cannot escape its obligation to build and maintain a highway system reasonably adequate to meet the requirements of modern motor vehicle transportation and to continue to keep pace in its highway policy with the development of the automobile. The appropriations recommended by the committee to carry out the proposed program are sufficient to provide for a satisfactory roadbed over which motor vehicles may operate. To further promote highway safety, the committee urged that when, in the judgment of the proper official, sidewalks adjacent to public highways are deemed necessary, they be built as a part of the highway project. At the present time state highway construction funds cannot be used for sidewalks.

Adequate highway lighting is something which cannot be overlooked or disregarded in the search for highway safety. For the purpose of affording an adequate test on the effectiveness of lighting in reducing night accidents on the highways and to ascertain the cost of providing and maintaining such facilities, the committee favored the installation of highway illumination over a reasonable mileage. In the opinion of the committee, there are certain types of advertising signs which constitute definite traffic hazards. It was recommended in the interests of safety that the proper official should be given the authority not only to prohibit the erection, but also to remove signs in this category. These are all matters having a vital bearing on highway safety.

Conclusion

At the 1936 session of the legislature, certain parts of the legislation necessary to make possible the adoption of the recommended highway program were introduced, but failed to be enacted into law.

The highway problem presents one of the pressing problems of the generation. The construction and maintenance of the modern highway system has gone far beyond the "hit and miss" stage. Planned development is essential. Sound engineering dictates that it must be solved in an intelligent and scientific manner. To do otherwise would be false economy. The proper solution can only be based on a sound comprehensive program with a method of financing such a program.

Next Week—Fitting the Road to Future Traffic

Work Reported by Bureau of Public Roads

Road work administered by the Bureau of Public Roads during the fiscal year ending June 30, 1936 considerably exceeded that of any previous year in point of projects approved, contracts awarded, and work placed under construction. Contracts were awarded for 22,300 miles at a cost of $489,000,000 of which $393,000,000 was to be supplied by the federal government. Work placed under construction totaled 21,800 miles at a total cost of $454,000,000 of which the cost to the federal government was $369,000,000. The 17,300 miles of road completed were built at a total cost of $280,000,000 including $241,000,000 in Federal funds.

During the fiscal year, 300 railroad grade crossings were eliminated, 10 elimination structures were reconstructed and protective devices were installed at 185 crossings. At the end of the year 1,240 eliminations were under contract—most of them under construction—and 168 elimination structures were under contract for reconstruction.

Gas and Steam Flow Problems Solved by Diagram and Slide Rule

By N. F. Hopkins,
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HAVING HAD OCCASION to calculate the flow of gas through pipelines, the writer was unable to find any simple formula for this purpose. Although Marks' "Mechanical Engineers' Handbook," page 357-358—1916 edition, gives formulas based on experiments by Fritchie, they are somewhat unwieldy. These have been reduced to a simpler form and the following diagrams prepared by which the problem can be easily solved by the use of the slide rule.

It is interesting to note that if the gas be regarded as a fluid and therefore incompressible, the formula develops into one closely approximating that for the flow of water.

Marks Mech. Eng. Handbook (Pages 357 358) shows that:

$$p(P - p/2) = cM^2RLT/(D/12)^5\,9\pi^2 = c77699540M^2LT/520gD^5 \quad (1)$$

Where p = the loss in pressure lb. per sq.in.
P = the absolute initial pressure lb. per sq.in.
M = the weight of gas flowing per second.
$R = 14.7 \times 144/dT = 53.34/g$. (2)
d = the weight per cu.ft. of the gas at a temperature of T.
T = the absolute temperature of gas.
L = the length of the pipe in feet.
D = the diameter of the pipe in inches.
g = specific gravity of gas, air = 1.

$$c = .0000022/(D/12)^{.269}(dw)^{.148} \quad (3)$$

w = velocity of gas ft. per sec. $= M/d\,.7854\,(D/12)^2$ (4)

and $dw = M/.7854(D/12)^2$. (5)

and $dw^{.148} = 1.0364\,M^{.148}(D/12)^{.296}$ (6)

and $c = D^{.027}M^{-.148}/503785$ (7)

$p(P - p/2) = 154.23M^{1.852}LT/520gD^{4.973}$ (8)

$M = D^{2.685}g^{.54}[p(P - p/2)/L]^{.54}(520/T)^{.54}/15.189$ (9)

Let Q = cu.ft. of gas per minute at atmospheric pressure and temperature of 520 deg. absolute.

Then $M = .0763gQ/60$.

and $Q = 51.77D^{2.685}g^{-.46}[p(P - p/2)/L]^{.54}(520/T)^{.54}$ (10)

and $p(P - p/2) = Q^{1.852}g^{.852}(T/520)L/1491.6D^{4.973}$ (11)

Approximate formulas for air and natural gas are as follows:

$$Q = (.48/n)D^{2\frac{1}{2}}\sqrt{p(P - p/2)/L}\,\sqrt{520/T} \text{ for air.} \quad (12)$$

$$Q = (.60/n)D^{2\frac{1}{2}}\sqrt{p(P - p/2)/L}\,\sqrt{520/T} \text{ for nat. gas.} \quad (13)$$

Where n is Kutter's coefficient of roughness varying from .01 for very smooth pipe to .013 for rough.

$$M = D^{2\frac{1}{2}}\sqrt{p(P - p/2)L}\,\sqrt{520/T}/2120n \text{ for steam.} \quad (14)$$

Let h = the height of a column of gas, the weight of which produces a pressure of p lb. per sq. in.

Then $h = 144p14.7T/.0763g(P - p/2)520$ (15)

And $p = .0763\,gh\,(P - p/2)^2520 \cdot 144T14.7$ (16)

Let Q' = the volume of Q cu.ft. reduced to a pressure of $P - p/2$ and a temperature of T.

Then $Q = Q'(P - p/2)520/14.7T$

$= 51.77D^{2.685}(520/T)^{2.54}g^{-.46}[.0763gh(P - p/2)^2520/144T14.7]^{.54}$ (17)

And $Q' = 3.762D^{2.685}(h/L)^{.54}\,g^{.08}(P - p/2)/14.7)^{.08}(520/T)^{.08}$ (18)

For steam g = 0.62.

And $Q' = 3.621D^{2.685}(h/L)^{.54}\,[(P - p/2)/14.7]^{.08}(520/T)^{.08}$ (19)

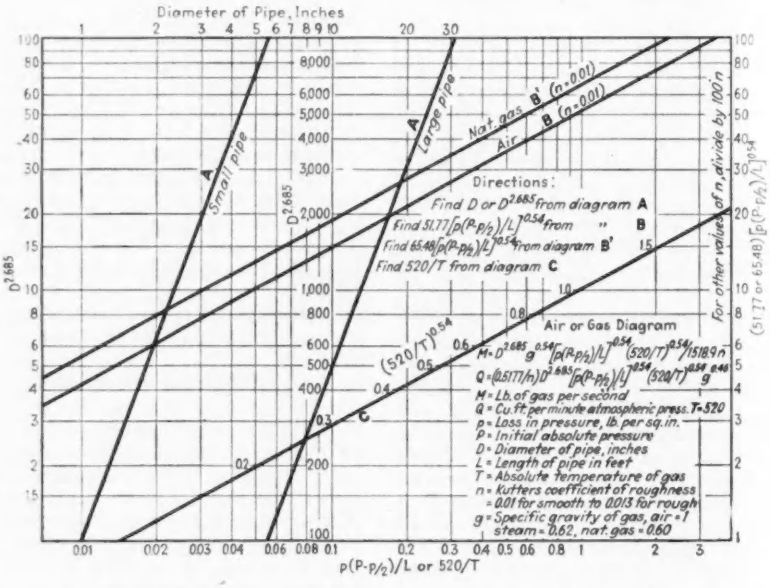
Diameter of Pipe, Inches
Small pipe
Large pipe
Nat. gas
Air
B' (n=.001)
B (n=.001)
Directions:
Find D or D^2.685 from diagram A
Find 51.77[p(P-p/2)/L]^0.54 from " B
Find 65.48[p(P-p/2)/L]^0.54 from diagram B'
Find 520/T from diagram C
Air or Gas Diagram
M = D^2.685 g^0.54 [p(P-p/2)/L]^0.54 (520/T)^0.54 / 15189n
Q = (0.517/n) D^2.685 [p(P-p/2)/L]^0.54 (520/T)^0.54 g^0.46
M = Lb. of gas per second
Q = Cu. ft. per minute atmospheric press. T = 520
p = Loss in pressure, lb. per sq.in.
P = Initial absolute pressure
D = Diameter of pipe, inches
L = Length of pipe in feet
T = Absolute temperature of gas
n = Kutters coefficient of roughness = 0.01 for smooth to 0.013 for rough
g = Specific gravity of gas, air = 1 steam = 0.62, nat. gas = 0.60
For other values of n, divide by 100n
p(P-p/2)/L or 520/T

FIG. 1—DIAGRAM for the solution of problems dealing with air or gas flow through pipelines.

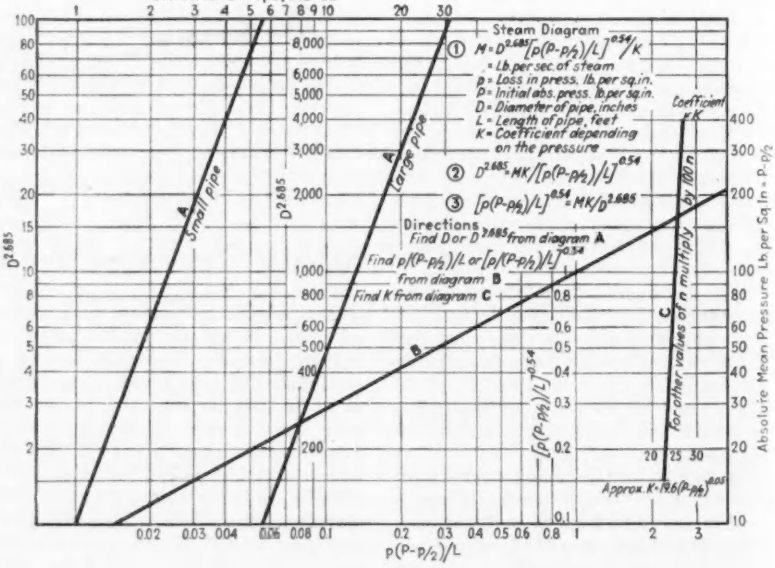
Diameter of Pipe, Inches
Steam Diagram
① M = D^2.685 [p(P-p/2)/L]^0.54 / K
= Lb. per sec. of steam
p = Loss in press. lb. per sq.in.
P = Initial abs. press. lb. per sq.in.
D = Diameter of pipe, inches
L = Length of pipe, feet
K = Coefficient depending on the pressure
② D^2.685 = MK/[p(P-p/2)/L]^0.54
③ [p(P-p/2)/L]^0.54 = MK/D^2.685
Coefficient K
Small pipe
Large pipe
Directions
Find D or D^2.685 from diagram A
Find p/(P-p/2)/L or [p/(P-p/2)/L]^0.54 from diagram B
Find K from diagram C
For other values of n multiply by 100n
Approx. K = 19.6(P-p/2)^0.05
Absolute Mean Pressure Lb. per Sq.In. = P-p/2
p(P-p/2)/L

FIG. 2—STEAM FLOW PROBLEMS can be solved with the aid of this diagram.

If a fluid instead of a gas is the substance flowing through the pipe, then the pressure and the temperature have small effect upon the flow (excepting as the temperature affects the viscosity) so that

$$Q' = 3.621\ D^{2.685}\ s^{.54} \quad \text{where } s = h/L \qquad (20)$$

This agrees closely with the Hazen-Williams formula (C = 115)

$$Q' = 4.14\ D^{2.63}\ s^{.54} \qquad (20a)$$

Ex. for a 12" pipe, s = .006

Gives $Q' = 180.6$ (20)

Gives $Q' = 180.1$ (20a)

Fritchie's experiments, therefore, seem to indicate that there is a close analogy between the flow of air and water.

Safety in Construction Discussed at National Meeting

A review of several papers presented at the 25th Annual National Safety Congress in Atlantic City, October 5-9

DELEGATES attending the Construction Section meetings of the 25th National Safety Congress at Atlantic City, N. J., last week learned that silicosis in construction can be easily controlled, heard themselves berated for excusing their accidents on the grounds "construction is different," got a lot of safe practice advice and participated in a spirited round-table discussion. A paper commanding much attention was that on the Ohio plan of attack against construction accidents, a program being carried out by the State Industrial Commission. The Construction Section met for three half-day periods during the five-day general convention, with an attendance of 100.

Silicosis

In plain but forceful language Dr. A. J. Lanza, of the Metropoliton Life Insurance Co., and an internationally recognized authority on silicosis, removed the mystery and misunderstanding surrounding the silicosis situation and gave the session a clear idea of the cause, prevalence and prevention of the disease in construction. He declared that silicosis was the only dust disease affecting construction. Furthermore, Dr. Lanza stated, silicosis can result only from the breathing of free silica dust. No other dust found in construction, either organic or mineral, is harmful to the human lung.

Dr. Lanza mentioned several conditions that must be present in the development of silicosis. First, the worker must be exposed to heavy concentrations of silica dust for a period of years. The disease is a chronic one, he stated, and takes years to develop. There can be no silicosis without silica, without heavy concentrations of fine, microscopic dust particles under 10 microns in size (a micron is 1/25,000 in.) and without long continued exposure.

Workable standards of health are still to be attained, but present knowledge indicates that, roughly, a dust concentration of less than 10,000,000 particles, ten microns or under in size, is not harmful. Naturally, the speaker pointed out, the amount of free silica in the dust, the concentration of dust, the length of exposure and the state of health of the worker all have a bearing on the contraction of silicosis. Dust from rock containing more than 5 per cent of free silica should be regarded as dangerous. The process by which the dust is created is also an important factor. Rock drilling in tunnels and mines, for example, is a greater silicosis hazard than open air drilling where air currents dilute and dissipate the dust.

In construction work silicosis itself rarely causes disablement, and fatalities from the disease alone are very rare. Almost every case of disablement or death where silicosis is involved is found to be complicated by tuberculosis or other lung infection. However, Dr. Lanza implied, the danger of silicosis in construction must not be minimized. Extraordinary precautions should be taken to safeguard the health and safety of tunnel men and others working in rock dust, especially in confined places.

The prevention of silicosis, Dr. Lanza said, is mostly an engineering problem, supplemented by medical control. Engineering methods of control are mainly at the source of the dust—the rock drill—by use of water, by vacuum exhaust systems or by both. Respirators as approved by the U. S. Bureau of Mines are satisfactory, but their use should be limited to temporary exposure. Whatever the system of control used, it must be properly maintained, otherwise it is worthless. He advocated the use of suction devices in open-air drilling in highly siliceous rock, though the hazard is not as great as that in underground drilling.

Many state health agencies are now equipped to offer service in dust hazard analysis. Dr. Lanza does not believe it practicable for a contractor or small operator to make their own analyses unless the size of operations warrants the hire of an expert.

In a paper on mineral dust hazards read before the Metals Section of the Congress, H. B. Meller, managing director, Air Hygiene Foundation of America, reiterated many of the statements made by Dr. Lanza. Mr. Meller declared that silicosis, uncomplicated by infection, is more of an impairment than a disability. It is not seriously disabling until it reaches the final stage, and does not of itself greatly shorten the life of a silicotic.

In speaking of the legal aspects of the silicosis problem Mr. Meller pointed out that each state is a separate sovereign and handles its problems in its own way. Uniformity is lacking, though statutes of many states are similar. The courts of the various states follow such precedents as appeal to them, consequently there is likely to be a wide divergence of opinion in legal decisions. A working alliance among the fields of knowledge—medicine, engineering and law—of which alliance industry and labor should also be important and sympathetic members, is necessary to control the dust hazard. Such unification of effort will foster the development of the science of koniology in this field.

Construction not different

G. O. Griffin, safety director of the Dravo Contracting Co. and affiliated companies, deplored the excuse of construction's poor safety record by the time-worn phrase "construction is different." Of 30 major industries construction stands 27th in accident frequency and 29th in severity. Mr. Griffin declared the best accident records in the construction field were those of an oil company, a public utility and a manufacturer. Why? Because, he said, the construction departments of these firms are not saddled with the belief that there must be a death for every floor in steel erection, and a fatality for every few hundred thousand man-hours of exposure.

Cement manufacture, quarry operations and other similar work offer just as great hazards as does construction, yet accidents have been greatly reduced in these fields because the will to do so was there, Mr. Griffin declared. He reported that an analysis of accidents in all of the Dravo Corp. activities showed construction was no worse than other departments, such as manufacturing, aggregate production and marine work. Construction accidents can be reduced by good workmanship and lack of haste, by good housekeeping on the job, and by a program based on adequate safety inspection, records and medical control.

Thomas P. Kearns, superintendent, Ohio Industrial Commission, outlined

the state's plan of organization and mode of attack against construction accidents. The following are direct quotations from his paper:

The Construction Safety Code of Ohio, generally recognized as one of the finest mediums of its kind, was developed to its present status with the constant objective of fair, equitable and workable requirements, fashioned along the lines of safe standard practice. Added to these standards is the permissible alternative of "equal or better" substitution. A condition below these standards is dangerous.

During the early months of 1935 we made a very careful study of the accident experience of the construction industry, and the analysis revealed that notwithstanding the prior depression years when there was practically little work, the industry's experience had not materially improved. We decided, therefore, to call together outstanding leaders of the construction industry for a full and frank discussion of the problem. The meeting was held in October, and a committee of three was appointed to select representatives of all branches of the industry and affiliated bodies. Early in the spring of 1936 another meeting was held and the "Ohio Construction Council for Safety and Compensation Insurance" was organized. The council consists of 17 members representing 17 branches of the industry and organized labor, each council member having an alternate in case of his absence or inability to attend. From the council an executive committee was organized consisting of seven men who are the executive officers of the organization.

Permanent committees have been established under capable leadership, consisting of (1) accident prevention, (2) rates and standardization, (3) legislative, (4) safety codes and regulations, (5) publicity and propaganda and (6) membership.

A 10-point program has been outlined as the immediate objective of the organization. It consists of the following:

A concerted, state-wide program to reduce accidents by adherence to safety rules and regulations; to see that injured employees get proper medical care, thereby hastening the period of rehabilitation; to insist that all employers amenable to the fund pay their premiums and hold certificates of coverage; to urge legislation requiring building departments of cities to have coverage certificates filed with plans and specifications; to urge similar requirements by federal, state and county authorities; to have architects incorporate these provisions in public and private contracts; to educate the public to the economic levies they assume through failure to abide by these requirements; to check up on the qualifications of physicians to prevent cases of malingering; to urge centralized procedure in the investigation and hearing of claims to obviate the expense of employers and claimants traveling to the state capital and to enlist the support of all construction interests in cooperative, accident prevention work, the handling of compensation insurance and other major problems confronting the industry.

The council is strictly a non-profit organization, its officers serving without remuneration.

Officers re-elected

All present officers of the Construction Section were re-elected to serve another term. These include: Chairman, Welton A. Snow, Associated General Contractors, Washington, D. C.; vice-chairmen, R. J. Reigeluth, New Haven, Conn., F. I. Rowe, Hicksville, Ohio, Maj. Elliott Vandevanter, U. S. Engineers, Washington, D. C., and Chester W. Wright, Niagara Falls, N. Y.; secretary, Robert McKinley, Detroit, editor of *Construction News Letter*, G. O. Griffin, Pittsburgh, Pa.

Higher Standards for Engineers

Work of ECPD in accrediting college curricula and in formulating advanced principles of grading by schools and societies shows trend toward establishing higher professional qualifications.

SIGNIFICANT views and action on the subject of establishing higher professional standards were reported at the annual meeting of the Engineers Council for Professional Development, held at New York Oct. 6. The first concrete results of action toward this objective were represented by the work of the Committee on Engineering Schools, which reported that it has completed the work of examining and accrediting engineering college curricula in practically the whole northeastern region (New England and the Middle Atlantic states) and that it will soon publish a list of accredited courses. The committee is now in process of extending its work over the rest of the country, so that within a year or two there will be assurance that all recognized engineering curricula will be up to a level of quality satisfactory to the ECPD.

Action in another direction was reported by the Committee on Professional Recognition, which outlined the principles which after several years' study it finds to be essential for the acceptance and grading of engineers on the basis of qualifications that will assure the profession of high qualifications. The recommendations, differing markedly from earlier progress reports of the committee, represent a long step toward harmonizing divergent standards of engineering qualification and putting them on a higher plane. While consideration of the recommendations was deferred to the next meeting, their ultimate adoption appears certain to have substantial effect on raising the standards of engineering competence and training.

Other activities that bear on advancement of engineering standards were reported by the committee on Student Selection and Guidance and the Committee on Professional Training. The former has continued its work in assisting students who take up engineering study to determine their vocational qualifications, and has also begun to analyze the effect of college instruction in developing the students, by test gradings of students in various subjects at the end of the first and second year as compared with those at entrance. The Committee on Professional Training has undertaken to organize and conduct a continuation training course for young engineers, both graduate and non-graduate, in cooperation with the Providence Engineering Society. This work, supplemented by the preparation of selected bibliographies of books to be read in continuation study, and other aids, is directed toward assisting the young engineer from the stage of graduation to the stage of recognition as member of a profession through registration or through society membership.

Accrediting college courses

During the past twelve months the work of accrediting schools in the northeastern region was carried on actively by the committee, organized in a number of visiting and examining committees, under instructions from the member societies of the Council. Chairman Karl T. Compton reported that all but three or four of the engineering colleges in this region have been visited and their several engineering curricula examined in detail, and that a list of the curricula accredited as a result of this examination will be published in the course of a month. About 40 institutions were covered.

Certain special problems were encountered by the committee, among them the question of evening instruction and specialized courses.

A few of the institutions submitted evening curricula leading to engineering degrees. For some of these the requirements were identical with those for the full-time day curricula. Where this was the case, the delegatory committee proceeded with its review and made its recommendations as usual. In other cases, however, the quantitative requirements of scope and content of the evening curricula, as well as the requirements for admission, were substantially below those for the day. The argument of the officers of administration followed the line of reasoning that evening students were more mature, and of greater average ability, so that even though less work was actually covered the same endpoint was attained. The main committee was not satisfied that such was the case, and decided to defer action on evening curricula which did not approximate the ordinary requirements of day curricula, pending receipt of a report from a special committee of four which was appointed to investigate evening curricula and recommend to the main committee a suitable course of action.

The matter of specialized curricula was given considerable attention. In general the committee was opposed to accrediting such curricula, since to do so might place undue emphasis on specialties at certain institutions, and perhaps cause other institutions which gave comparable curricula as an option under a major branch of engineering to change to a more highly specialized degree. Since, however, sufficient information as to the degree of specialization throughout the country would not be available until all the institutions in the remaining regions had been visited, it was agreed that all curricula would be grouped according to (a) those which are generally recognized branches of the engineering profession, and (b) those of a specialized nature which may be found at only a few institutions as separate curricula and are generally included as options within one of the major curricula. The regional committee should give consideration to the quality of the scientific and engineering content of these latter curricula, but definite action with respect to accrediting will be deferred pending completion of the program throughout the country, at which time the main committee will determine what action it will take concerning these specialties.

In considering extension of the work over the rest of the country, the committee had to decide on whether to make its minimum standards of acceptability of curricula and instructional conditions uniform for the whole country or whether slightly lower standards would be acceptable in certain regions. It concluded to adopt a uniform minimum standard, and in order to assure that the desired uniformity of judgment will be applied care is taken to establish interchange between the delegatory or examining committees assigned to the different regions. Further, their work is directed by a detailed memorandum outlining policies and procedure.

With respect to follow-up work, the committee has taken in view the probability that periodic review and reinspection of the various colleges will be desirable, and has concluded that "from time to time each curriculum will have to be reinspected, perhaps every five years, though under special conditions earlier review might be required."

Three steps in recognition

In its work of correlating the various methods of formal recognition of the development of an engineer, the Committee on Professional Recognition reported through its chairman, C. N. Lauer, that three stages are to be distinguished in the development of an engineer: 1, professional education; 2, registration as a professional engineer, representing legal admission into the profession, and 3, membership in a professional grade of a recognized engineering society, representing the individual's recognition by his colleagues. It is this stage that the committee is aiming to improve by correlation. Steps in this correlation that are being furthered by ECPD are the establishment of recognized national standards of quality for engineering schools through the accrediting program, attainment of greater uniformity and higher criteria in the registration of engineers, and approach to greater uniformity in admission requirements of the major national engineering societies. The minimum definition of an engineer formulated by the committee three years ago and the standard grades of membership approved by ECPD, which include use of this minimum definition, are believed to be influences working toward uniformity of membership qualifications.

Inasmuch as this minimum definition includes the passing of written examinations, and such examinations are usual as a registration requirement, the committee suggests that "instead of duplicating such examinations the engineering societies may accept the results of corresponding examinations passed in securing registration under the state laws."

To integrate the three elements of recognition into a consistent whole the committee proposes that professional education by graduation or examination be made universally a prerequisite for registration and for society membership, and that ECPD assist in amending registration laws that do not demand such prequalification. It also proposes that all engineering societies be urged to adjust their requirements to specify these same qualifications for membership. Finally it proposes that registration be made a uniform prerequisite for admission to the grades of membership of the national engineering societies. On the latter point it says, however,

> This does not mean that any candidate is to be accepted for membership merely because he is registered or licensed. State registration is recommended as a desirable basic requirement, not as an all-sufficient requirement.
>
> Unless any engineering society takes the position that the state maintain qualification requirements higher than should be expected of professional grades of membership of the society, there would appear to be no valid objection to requiring registration as a prerequisite. If on the other hand any engineering society takes the position that any registration requirements in any state are inferior there would appear to be no objection to challenging any candidate who fails to meet even such inferior requirements.

Exceptions are suggested for applicants from the 16 states that have no registration laws or incomplete laws.

The study of present correlation between registration and society membership showed, the committee reported, respective registration percentages of 56, 25, 29, 13 and 11 in the professional grades in the A.S.C.E., A.S.M.E., A.I.E.E., A.I.M.E., and A.I.Ch.E. In the junior and affiliate grades the corresponding percentages are 15, 4, 7, 2 and 5.

Specific recommendations offered by the committee are as follows:

1. ECPD should urge upon its participating engineering societies the actual adoption and application of the "Minimum Definition of an Engineer" as a minimum requirement for admission to membership. Evidence of professional education (by graduation or examination) should be specifically included in the prescribed membership qualifications.

2. ECPD should urge and encourage the early adjustment of membership grades in the participating engineering societies to conform to the "Standard Grades of Membership" previously formulated and ratified.

3. ECPD and its participating bodies should render all possible assistance to effect uniform registration laws in states which do not have them, to improve and to strengthen the registration laws where they now exist, and to effect among these present laws a higher degree of uniformity as to requirements and as to form of recognition.

4. ECPD should give its assistance and support in amending any state registration law in which evidence of professional education (by graduation or examinations) is not yet clearly specified as an essential prerequisite.

5. ECPD should recommend to all participating and interested engineering societies that state registration of a candidate be established as a *minimum* prerequisite for admission to professional grades of membership, with such provisional exceptions as present circumstances may justify.

6. ECPD should urge and support the simplification, toward greater uniformity, of the wide variations of degrees conferred upon graduation from engineering schools.

7. ECPD should recommend to all engineering schools that the professional degree be eliminated as a degree in course; and that (when it is awarded for post-collegiate professional recognition), it be not conferred until after the candidate has secured professional registration as a *minimum* prerequisite.

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Costs Are Up

IT IS MORE THAN LIKELY that the rejection of bids by the PWA in two housing-project cases last week involves the influence of burdensome contract conditions like those that featured the earlier case of bidding for the Ten Eyck housing project. Such conditions as the separation of inspection from the technical direction of the work, absence of performance standards, and the like, mean that a large contingency item will be included in every bid—except perhaps from a bidder who is willing to buy into a lawsuit with the government. But the unexpectedly high bids also reflect clearly the current rise in construction costs. The *ENR* construction cost index has been going up for some time, an indication of a rise in basic costs that confirms predictions made months ago. Contract prices have risen even more, because the period when contractors were willing to bid at or below cost is over. As all prospects are for continuation of the change in both these factors, the construction buyer must look forward to rising prices for some time to come.

Consider Also Efficiency

IN THE INCISIVE practical discussion of road intersections presented by H. W. Giffin last week the matter of safety was properly made the basis of the argument. Together with safety, however, an economic issue is involved, for every road intersection means expense and waste. Elements of expense are the cost of delay, the carrying cost of the investment wasted by the resulting reduction in road capacity, and the operating cost of signals. The loss through delay is known to every road user; its minimum amount is the full traffic of one road multiplied by one-fourth the traffic interval, which in the case of two roads each carrying 1,000 vehicles a day, with 1½-min. traffic interval, amounts to well over $1,000 per year. The investment loss from reduced traffic capacity, which varies with type of road and capacity margin, is an even larger item. Adding the operating cost of the crossing itself the total cost will be found to reinforce strongly the safety argument against grade intersections. This fact confirms the common-sense principle that safety is promoted by smoothness of traffic flow and reduction of friction and interference; in other words, safety and efficiency go hand in hand. When road practice gives full recognition to this principle we will be well along toward making roads safe.

Rainfall Data Needed

EVERY HAPPENING in the field of water lays new emphasis on the need for more complete information on rainfall and runoff, not only as an aid to engineers in determining the amount of water that can be obtained from any watershed but as a measure of public safety. For one thing, only more complete data can reduce the number of dam failures caused by spillways of inadequate capacity. There are many rain and river gages in this country, but not nearly enough, and such as exist are not distributed to best advantage. Further, the collection and compilation of hydrologic data at these stations is not properly coordinated, and many of the data collected have not been published. It is true that existing information suffices to give a fair picture of general conditions in any region, and average rainfall and runoff is known with reasonable accuracy, but this is by no means enough for safety. Too little is known about maximum rainfall and peak runoff, whether in the wide-spread storms that produce great floods or in the local storms that have destroyed so many small dams. More regular gaging stations strategically placed are urgently needed to speed the coming of the time when hazards of this kind can be eliminated.

No Water Without Vision

WHEN A WATER-SUPPLY PROJECT is proposed and bonds are to be voted there always are opponents. The time element is the objection most frequently cited: "All right for sometime in the future but we don't want it now. Why spend this money for something we won't need for years to come?" Publicity is necessary to show voters that water cannot be ordered for prompt delivery, like goods for which a merchant telephones to the warehouse. The time element is an essential; often there must be years of preparation during which progress is painfully slow. The development period on the Owens Valley aqueduct for Los Angeles was about nine years; the first contract on the Hetch Hetchy water supply job was awarded almost 20 years before Hetch Hetchy water reached San Francisco. New York's water-supply experience is that ten years is the minimum period from inception to completion of a new project. Start of the Colorado River aqueduct (a 1925-1939 project) was delayed by need for special legislation; because the people feared a state power scheme, the first enabling act was defeated in the state legislature, and it took two years to allay these fears and pass the necessary bill. In addition to such incidents in preliminary stages there is no shortcut on projects which involve long tunnels. Frequently the right time to start a great engineering project is determined by economic or psychological conditions. The late William Mulholland had an apt saying with regard to a water supply: "If they wait until they have to have it they won't need it." The large cities—New York and Los Angeles among them—have already learned that vision is essential if water needs of the future are to be covered before it is too late; cities of lesser magnitude will find that the same truth applies to them.

Go Back to Boats

CONVERTING A RAILROAD GRADE into a highway is not an unusual operation; it has been done frequently in this country following the relocation of a main line or abandonment of a branch. But abandonment of the 125-mile Florida East Coast Railway line along the Florida Keys to Key West and the conversion of that line into a toll highway, as is now proposed, has a significance not found in earlier similar operations. It was a bold piece of engineering that pushed the East Coast railway line out over the keys to a rail-water terminal through which it was hoped to build up a profitable interchange with Cuba, and the concrete structures by which the major channels were bridged still are recognized as pioneer products of the art of building concrete to withstand attack by seawater. Traffic over the line, however, did not come up to

expectations, and in 1934 the hurricane swept away so much of the low-lying track on the keys and destroyed so many timber trestles as to make reconstruction as a railway line unjustified economically; such business as the railroad still has with Cuba can be handled to advantage from a less exposed port on the mainland. But no sooner had the railroad company asked the I.C.C. for permission to abandon the line than others proposed to take over the grading and the remaining structures for a highway. With federal relief-act funds the reconstruction is about to start. Doubtless less money will be required to make a passable highway, but even assuming that the railroad company should make the highway district a present of its right-of-way and structure it is difficult to see how the cost of building the highway can be justified. Though this scheme for keeping the keys open to sportsmen may be one to stir the imagination, cold logic argues that it would be better to let the fishermen go to the fishing grounds in boats than to build them an automobile road.

To Crystallize the Profession

IN THE WORK reported at its fourth annual meeting last week, the Engineers Council for Professional Development gives promise of exerting a strong and lasting influence on engineering progress. The vague purposes and groping idealism of the Council's early days have evolved into practical effort, and divergent aims are merging in effective cooperation to develop better engineers. The work in progress justifies the hope that it will lead to crystallizing a clearly defined profession out of our now uncoordinated body of professional and craft groups.

Only on rare occasions in the past has a definite regulating force guided the development of engineering. Three-quarters of a century ago the rise of technical colleges and societies reoriented the profession's course by placing emphasis on scientific grounding of practical accomplishment. On the whole however the engineer remained self-made and self-named; engine runners, fledgling rodmen and machinery repairmen called themselves engineers, and sometimes indeed the absence of a definition of characteristics and qualifications led to creating engineers by political preferment. Recently registration has done much to correct this fault, by establishing legal definitions in which both scientific knowledge and practical capacity are recognized. Now the ECPD enters as a new influence to the same end of defining the profession and raising its level of competence, and it is likely to prove an influence of exceptional power.

Its strength lies in its method. It has undertaken to correlate college, society and registration system. What this means is easily understood in view of the limitations that now restrict each of these three agencies in its attempts to improve engineering practice and develop better engineers. So long as there are widely divergent views of what are the functions of the engineer and how he must be equipped, the college cannot decide on training methods, nor the society define professional qualifications, nor the registration system fix a legal definition, in such a way as to meet all requirements. Progress requires that we know in precise terms what the engineer is, what he does, and how he must be equipped for his work.

A number of interrelated objectives are occupying the Council. Chief among them are establishing minimum educational and experience qualifications for engineers; testing and certifying the adequacy of college courses in harmony with these criteria; creating means to strengthen the postgraduate training processes that develop the working engineer; and coordinating his advancement to recognized professional status through registration and society membership. The committee proposal that registration be made a minimum prerequisite for admission to the societies is a particularly promising step in coordination. It is not an easy matter to carry out these aims, and the end of the work is not even in sight. Nevertheless its ultimate success is assured both by what it has so far accomplished and by the deeply interested effort of those engaged in the work.

One important innovation made by the ECPD may affect both society structure and professional organization extensively. This is the recognition of *professional grades* of membership in engineering societies. Once these grades are clearly established and are tied in with the educational and legal definitions of the engineer, the society system is certain to undergo improvement, especially if the concept of professional membership finds acceptance by the many specialist organizations that play so large a part in the society field. To bring about such acceptance seems to be a particular problem for the Council, for it is too much to expect that the entire profession can be brought within the fold of the half-dozen societies now joined in the Council's work.

How far the ECPD's aims will change as time goes on cannot now be foreseen; the movement is youthful and is bound to change and mature as it grows older. On present showing it seems certain to go forward to larger and more important activities. Both the purpose of the movement and the spirit which animates it warrant this expectation. These same factors guarantee that the ECPD will succeed in avoiding any danger of obstructing the free advance of engineering.

Because the movement includes what in a sense is the setting of standards, there has been a not unjustified fear that it may have a stagnating influence. Common experience shows that standardization tends to freeze existing conditions and check the improvement of quality. But setting minimum standards of engineering qualifications can never discourage the development of increased knowledge and larger abilities. Moreover, the minimum will undoubtedly be raised from time to time as the art advances.

More weighty is the apprehension that the ECPD's activities may tend to close all avenues to the profession other than college education. There appears to be no ground for such a fear. But it is undoubtedly true that other avenues will become more difficult to travel as the essential qualifications of the engineer become more clearly marked out and accepted. This very process however may open a road to the development of engineering craftsmen, for whom there is likely to be increasing need in future.

On present evidence the forward course of the ECPD movement will have an important and beneficial influence on the art and the profession. Supported by the purpose of shaping a profession qualified to do the world's work, and carried on with rare judgment and energy, it will further the art by strengthening engineering education, promoting continuation training, and raising the appreciation of engineering accomplishment. And finally, if it extends its harmonizing work to the point of influencing colleges to educate engineers rather than various kinds of engineer, it will in time build up a truly integrated profession.

CURRENT NEWS

PWA Allots Nineteen Million

Grants are still on 45 per cent basis—Such disbursements under the new program total $71,947,000

TWO NEW sets of allotments from the $300,000,000 fund appropriated by the last Congress provides for PWA grants of $18,981,000 and $2,072,000 in loans. The total cost of the projects involved is $42,235,000. All of these grants are on the basis of 45 per cent of the cost of labor and materials.

The largest single allotment of these groups is a grant of $2,434,500 to New York City to build a westerly approach to the new Triborough Bridge. The second largest is to Chicago, which is granted $1,717,363 for a large street-paving project to provide connecting links between state highways and the city's arterial boulevards and avenues. All of the remaining grants are for less than a million dollars, and most of them are for less than two hundred thousand.

Since July 28 the PWA has made allotments for more than 1,073 projects with an estimated construction cost of $158,732,000. The federal government has granted $71,947,000 for these projects. Because the sponsors have been able to obtain the remaining part of the cost of projects from private financing, it has only been necessary for the PWA to loan $6,232,000.

The finance division of PWA recently reported that, as of Sept. 29, the profits on resale of bonds obtained through PWA loans had amounted to $8,251,000. Interest payments on these bonds had amounted to $16,186,000. Interest payments go directly into the United States Treasury. The profits from bond sales revert to the revolving fund.

The PWA had purchased, up to Sept. 29, $599,327,000 of bonds, of which $448,273,000 have been turned over to the RFC. Up to Sept. 1, RFC had actually sold $243,611,000 worth of bonds to the public.

Tokyo-Yokohama Canal To Be Completed

The 14-mile ship-canal between Yokohama and Tokyo will be completed as a government project within the next seven years to provide navigation between the two port cities. The canal project has been pending since 1920 when the privately financed Tokyo Reclaiming Co. was organized. Work was started in that year from the Yokohama end and 4½ mi. of the canal was completed.

The rest of the work, which lies within the territory of the Tokyo Prefecture, will now be completed by the prefecture and the $12,000,000 cost will be financed by floating prefectural loans.

The canal will be 29 ft. deep at low tide and will vary from 1,950 to 2,200 ft. wide.

Water Suit Again Rejected

The U. S. Supreme Court, at the opening of its winter session on Oct. 12, denied the petition of the state of Arizona for rehearing of its plea for a judicial determination of its rights to the waters of the Colorado River. Arizona is the only state that did not become a party to the Colorado River Compact of 1922. Last year it petitioned the court for leave to enter suit against the six states agreeing to the compact (*ENR* Nov. 28, 1935, p. 760), but that plea was rejected (*ENR*, June 4, 1936, p. 824). In rejecting the plea the court reviewed the history of the case in detail but based its finding on the conclusion that the United States was not made a party to the suit, which is necessary because of its interest in Boulder Dam. To make the United States a party requires an act of Congress consenting to the suit.

Housing Bids Rejected On Schenectady PWA Project

PWA Administrator Harold L. Ickes on October 9 rejected all bids for the construction of the Schenectady, N. Y., low-cost housing project for being "excessive and adverse to public policy." The contract will be re-advertised immediately.

The low bid of $1,039,000 was submitted on October 1 by the Thomas C. Brown Company, Inc., of Schenectady. PWA's refusal to accept this offer was based on the recommendation of H. A. Gray, director of the housing division, who said that "according to careful estimates, the lowest bids were far in excess of just demands for the work."

On October 5, PWA rejected all bids for the Brewster project in Detroit for similar reasons.

Survey Reveals Shortage Of Skilled Electrical Workers

A definite shortage of skilled electricians in the building trades has been revealed by a survey just completed by *Electrical Contracting*. Even in the larger cities, the report states, where new commercial building construction has not yet shown any great improvement, the supply of good mechanics is very small. A study of the labor situation was made in 36 cities having a combined population in excess of 22,000,000.

The report goes on to say that in spite of the condition found to exist, with few exceptions nothing is being done about it. The International Brotherhood of Electrical Workers does not recognize any shortage. At the organization's headquarters the statement was made that while there had been a sharp rise in employment there was not even an impending shortage of union wiremen nationally. The brotherhood guaranteed to supply on demand any number of skilled electrical workers any place in the United States.

Engineers Warned Of New Attacks

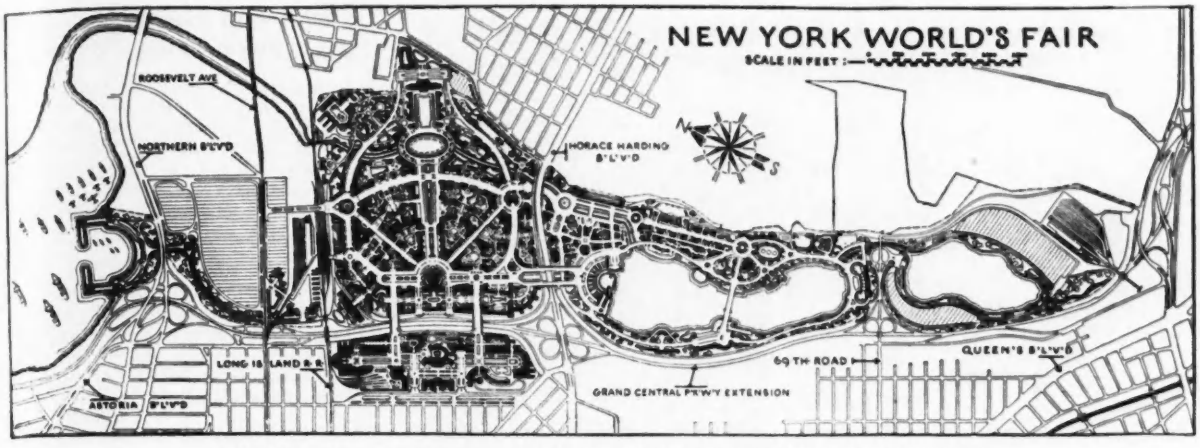
National Society of Professional Engineers Advised of Efforts to Modify Engineer License Laws

ENGINEERS will be called upon to defend their license laws against a new form of attack when state legislatures reconvene, said D. B. Steinman, president of the National Society of Professional Engineers, at the opening session of the society's second annual meeting, held in Washington, D. C., Oct. 12-13. This attack, said Dr. Steinman, will come openly from the National Association of Power Engineers, an organization of stationary engineers with a large membership, but the open attack, he added, will receive considerable undercover support from within the engineering profession itself from those who still think that license laws are unnecessary and undesirable. As an example he cited his recent trip through Texas where, as president of the National Society, he urged engineers to strengthen and support the state license law. On that trip he was followed by officers of the American Institute of Electrical Engineers who spoke against license laws.

Objections of stationary engineers

Dr. Steinman said that some months ago he had met with representatives of the National Association of Power Engineers to discuss their objections to engineer license laws. That organization feels that the definition of engineering in the pro-engineers' efforts to restrict the use of the it covers the work of the stationary engineers, putting them in the position of violating the professional law; further, the stationary engineers see in the professional engineers' efforts to restrict the use of the term engineer to licensed professional engineers an attack on their long-established right to use the title engineer. At the conference Dr. Steinman put forward the proposal that if the members of the National Association of Power Engineers would agree to limit their use of the title and would call themselves "operating engineers" he would recommend that the professional license laws be modified to exclude the work of operating or stationary engineers and to permit the use of the title "operating engineer" by properly qualified men in that field. Those present at the conference appeared to find the proposal acceptable but the association, at its recent meeting, repudiated the idea and began to collect a "war chest" with which to fight for modifications of license laws.

A membership in the society of 3,360, as of Oct. 12, was reported to the meeting by Willard S. Conlon, executive secretary. New York, Ohio, and New Jersey have the largest membership, totaling nearly 2,700. Organization of a state society of professional engineers in California will be an accomplished fact within a few days, said Mr. Conlon, and societies are being organized in two other states not now having



LAYOUT AND THEME OF 1939 NEW YORK WORLD'S FAIR ANNOUNCED

The theme of the New York World's Fair, to be held in 1939 and 1940 in Flushing Meadows in the borough of Queens, has been announced as "Building the World of Tomorrow." The general aspects of the theme will be correlated by exhibits located in a 250-ft. tower, the theme building, placed at the center of the radiating roads in the main section of the fair grounds. The detailed exhibits will be segregated into ten zones, each dealing with one phase of the subject: shelter, education, public and social services, government and cooperation, health, recreation, sustenance, the arts, and the basic industries. To the south there will be a mile-long amusement center circling around the edges of an artificial lagoon. Still farther to the south will be a parking area and the station and storage yards of the municipally owned Independent Subway. Another parking area and the station and storage yards of the Roosevelt Ave. elevated line will be placed to the north between the main fair grounds and the harbor, which is being constructed in Flushing Bay at a cost of $250,000.

Highway transportation to the fair will be provided by the Grand Central Parkway extension, which runs along the west side of the fair grounds; Harding Boulevard running through the fair grounds; and Northern Boulevard cutting through the harbor section. Parking space for 30,000 automobiles daily will be provided, and bus terminals will be able to handle 50,000 passengers daily. Rail transportation will be provided by the Long Island R.R., with a station at the fair grounds; the Roosevelt Ave. elevated transit line, with a station and storage yard at the fair; and the Independent Subway which now has a station and storage yard at the southern end of the fair grounds and which will be extended a distance of two miles along the eastern boundary of the site. A system of intramural buses is being developed.

A $10,000,000 WPA program in the borough of Queens for this winter and next spring will be largely devoted to the widening of narrow streets leading to the fair site.

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such societies. Mr. Conlon said further that the administration of the national society had cost $2.80 per member as against the $3 per member paid in to the national society by state societies, but he added that the administrative expenses shown in the treasurer's report did not represent all that had been spent in developing the national society because national officers had spent about $4,000 out of their own pockets.

In discussing Mr. Conlon's report question was raised from the floor as to whether it was good policy to remit part of the dues of new state societies as the directors had done in two instances. After considerable discussion the action was endorsed as in line with the society's announced policy of fostering the development of new state societies.

Federal Relief program

Three subjects were scheduled for discussion at the second session of the convention: engineering registration, engineering education and the federal relief program. On the latter subject six speakers from federal departments gave factual presentations of the many elements of the government's relief operations, giving special attention to the relation of these activities to engineers. For the concluding part of the afternoon program a general discussion of the relief program had been scheduled, but as this latter discussion got off into political questions the chairman, Thomas W. Battin, adjourned the meeting.

Other actions by the society will be reported in a subsequent issue.

A.G.C. Disputes WPA Denial Of Blame for Labor Shortage

Edward J. Harding, managing director, Associated General Contractors of America, has taken exception to statements made by Works Progress Administrator Harry Hopkins in a radio address Oct. 9 denying that WPA is responsible for an artificial shortage of skilled construction labor. Administrator Hopkins challenged the charge made by the A.G.C. several months ago and stated that his request for specific information had gone unanswered by the contractors. In reply the A.G.C. made public a complete file of correspondence on the subject of labor shortage which it had received from its members, which was, in turn, submitted on July 2 to the WPA Labor Policy Board together with a memorandum charging that WPA officials "have refused to permit their better men to go on contract jobs, for the stated reason that they were not going to hamper or disrupt their own organizations." Mr. Harding states the entire file was returned on the same day by WPA with a request for additional information. He insists that the association has made a prima facie case and that it is up to WPA to follow the accusations through. He stated further:

"It is true that this situation was brought before the WPA three months ago, as asserted by Administrator Hopkins, and at that time facts were laid before Father Haas of the WPA Labor Policy Board, giving sufficient information for WPA to make an investigation that contractors desired to hire persons known to be working for WPA, but who were refusing work with private contractors for full time work at prevailing wages. Mr. Hopkins further refers to a $40 or $50 a month subsistence wage, which likewise is not in accordance with the facts. We are speaking of skilled labor employed by WPA at wages from $70 to $95 a month."

Federal Aid Disbursements Show Record First Quarter

Federal aid disbursements have been much higher during the first quarter of the fiscal year 1937 than for any previous quarter. In the period from July 1 to Oct. 9, disbursements of federal aid funds amounted to $127,157,000.

The following table shows a comparison of the disbursements for the first quarter of 1937 with the disbursements for full fiscal years since 1930. These figures represent only payments to states for construction work and do not include administrative expenditures.

FEDERAL AID DISBURSEMENTS TO STATES

Fiscal Year	Total Expenditures
1937 (July 1-October 9)	$127,157,000
1936	224,073,000
1935	274,668,000
1934	221,715,000
1933	163,398,000
1932	186,275,000
1931	153,637,000
1930	75,881,000

There have been additional expenditures for national forest roads, public land roads and other purposes which, however, are small in comparison with major funds.

SHEETPILE CUTOFF OF PINE VIEW DAM NEARS COMPLETION

The sheetpile cutoff of Pine View Dam of the Ogden River (Utah) project of the U. S. Bureau of Reclamation has been completed across the river bottom and now is being constructed up the side slopes. The dam is to be a combined earth, gravel and rock fill. The cutoff here shown will extend up into a core of clay, sand and gravel. At the upper right is the intake of the outlet tunnel.

No Studies Will Be Made Of Lake Mead Weather Effect

No government agency is planning any special study of the effect of Lake Mead, formed by Boulder Dam, upon the weather in the surrounding area.

Considerable discussion has arisen as to whether the formation of a large artificial lake in a region previously without large masses of water might not cause marked effects on local weather conditions. The question arose principally as the result of statements by airline pilots that they had noticed a marked drop in temperature at considerable elevations above the lake.

However, both the Geological Survey and the Weather Bureau state that they do not plan to make any special studies of this effect. They are of the opinion that while unquestionably a large amount of evaporation will take place from the new lake, the effect of this upon local rainfall will be imperceptible. Local evaporation is only a minor factor in rainfall, which is determined by the large-scale distribution of atmospheric current, the distribution of mountain ranges, and similar factors. Local evaporation is quickly scattered over a wide area, and it is unlikely, they state, that the Lake Mead section will notice any increase in local precipitation. Moreover, if any conclusive results were to be obtained, it would be necessary to check long-term periods, rather than individual years, and to compare these records with test areas removed from the Lake Mead influence yet having comparable climate. For these reasons, the Weather Bureau, which has a number of observation stations in the surrounding territory, does not consider that any extra stations are necessary.

The only comparable situation that has been studied dealt with the Salton Sea, in southern California, where records before the formation of the large lake were compared with those of the following years. The conclusion reached was that the formation of the lake had no perceptible effect on precipitation locally.

Federal Funds Allotted For Flood Damaged Bridges

A total of $1,743,536 has been allotted by the President in two groups of allotments, made on Sept. 30 and on Oct. 8, for construction and reconstruction of bridges damaged or destroyed during the 1936 flood in Maine, Connecticut, New Hampshire, Vermont, Pennsylvania, and Virginia. These funds were allotted from the appropriations of the Emergency Relief Act of 1936. The projects will be carried on under the supervision of the Bureau of Public Roads.

Maine received an allocation of $102,200 for reconstructing a bridge over the Androscoggin River between Lisbon and Durham and also received $26,400 to supplement a previous allocation of $49,000 for the reconstruction of the Morse Bridge at Rumford.

Allocations totaling $123,200 were approved for nine projects in Connecticut. New Hampshire received allocations of $620,250 for seventeen projects.

Pennsylvania received $849,336 to carry out seventeen projects in the flood area. The largest single project in this group is replacement of a bridge over the Sinnemahoning Creek in Dauphin County at a cost of $112,440. Vermont received $13,000 to repair the Ewing Bridge in Windham County. Virginia received $9,150 to construct a bridge over the Tye River in Nelson County.

Diversion Rate Unlimited On Platte Valley Project

A decision delivered on Sept. 24 by Attorney General Wright, of Nebraska, at the request of state engineer Tilley clarifies the right to store Platte River water of the Platte Valley Public Power and Irrigation District and clarifies also the powers of the state engineer in regard to diversion of river water for storage purposes.

The water rights of the Platte Valley district arise from two separate appropriations. One appropriation grants the right to store 140,000 acre-ft. of water per year but limits the rate of diversion to 325 sec.-ft. A second, and somewhat later, appropriation, grants the right to store 150,000 acre-ft. at a rate limited to 1,000 sec.-ft. The district recently petitioned the state engineer to modify these appropriations so as to remove the restrictions on the rate of diversion. State engineer Tilley then asked the attorney-general to deliver an opinion as to whether the restrictions in the appropriation had the force of law, whether the state engineer's office had the power to modify an appropriation once granted, and also whether the later appropriation was added to or superseded the first appropriation.

Attorney-General Wright stated that in his opinion the state engineer's office did not have the power to modify an appropriation once granted except by giving notice to all persons interested and holding a public hearing. The opinion stated, however, that in this case no modification was necessary since the limitations on the rate of diversion were automatically void. The state engineer, he stated, had no power to limit the rate at which water might be diverted from the river for storage purposes. The attorney-general also stated that the two appropriations were entirely distinct and that the Platte Valley district had the right to store 290,000 acre-ft. per year.

The decision that the state engineer cannot limit the rate of diversion applies only to diversion for storage purposes. Diversion for irrigation purposes is always limited as to the rate of diversion.

Record Low Flows Observed On Mississippi During Drought

Mississippi River gages of the U. S. Weather Bureau between St. Louis, Mo. and Natchez, Miss., recorded new low water minimums during the recent drought, according to reports reaching Washington. The amounts by which stages fell below previous records at a number of typical points, and the length of time during which records have been kept in each, is as follows:

Place	Feet Below Previous Record	Years of Record
St. Louis	1.1	78
Arkansas City	1.4	52
Greensville	1.7	45
Natchez	0.2	66

The Missouri River, which runs through the heart of the drought area, did not approach recorded lows at any point, nor did the Arkansas River. The Red River broke previous records at only a few points.

Good Progress Reported On Reclamation Bureau Program

The Bureau of Reclamation reported on Oct. 8 that during the three years of its emergency program contracts for construction and for purchase of materials have been let amounting to $141,857,000. Of this amount, $85,975,000 was for construction and $55,882,000 was for the purchase of materials, equipment and supplies and to finance work by government forces.

The chief items in the program are 35 dams for conservation of water in the West. Of these dams, four have been completed, nineteen are under construction, and contracts for the construction of four more soon will be ready for award. Eight additional dams are in various stages of preliminary design.

A total of 11,499 men are employed by contractors on construction now in progress, and 3,951 are employed on work being done by government forces, making a grand total of 15,450 men actually employed at the site of construction.

Dams to be started

The four dams about to go into construction are the Boca dam, on the Little Truckee River in California, which will store water for the Truckee Meadows area of Nevada; the Marshall Ford dam, a flood control dam on the Colorado River in Texas; the Fresno dam of the Chain of Lakes storage project in Montana; and the Pine River dam which is to be constructed near Durango, Colo. Bids for the Boca dam are being studied preparatory to awarding the contract. Bids have been called and will be opened on Oct. 20 for construction of the Marshall Ford dam. Bids also have been called and will be opened Oct. 30 for the Fresno dam. The Pine River dam will be advertised in January with bids probably being opened early in February.

The eight dams now being designed include a few large storage dams, such as those of the Central Valley project in California, and several small diversion dams. Several of these will be advertised in the next few months.

Allotments of $33,000,000 Made for Resettlement Projects

The President has made allotments totaling $33,000,000 for the field operations of the Resettlement Administration.

One allocation of $20,000,000 will be used for completion of rural resettlement projects already under way. These funds will be used for construction work on 57 projects located in 29 states.

A total of $3,000,000 was allocated for the construction of farmstead units in connection with three suburban resettlement projects. Greenville, near Washington, D. C., Greenhills, near Cincinnati, Ohio; and Greendale, near Milwaukee, Wis. Each project received $1,000,000. Construction of these farmstead units will supplement the housing construction work which is already well under way on all three projects. The remainder of the $33,000,000 is for rural rehabilitation loans and for emergency drought relief.

Water Problems of Wisconsin Cities Discussed at AWWA Section Meeting

A WATER and sewage works operators registration bill presented Oct. 7 at the meeting of the Wisconsin Section of the American Water-Works Association was discussed, and the committee having it in charge, W. U. Gallagher, chairman, was requested to have it introduced into the next session of the state legislature. The registration bill covers superintendents and operators of water works, water purification plants, and sewage treatment plants. The state board of health would issue the certificates and might revoke a certificate for incompetency, neglect of duty, or disregard of regulations of the state Board of Health. A city would be liable to a fine of $10 per day for violation of the act.

Four papers considered operation problems. Cold weather troubles last winter were recounted by Walter A. Peirce, Racine, and hot weather difficulties due mainly to high consumption, exceeding the well capacity, were presented by C. P. Gross, Wisconsin Rapids.

Water purification

Modern trends in water purification practice were outlined by F. H. Waring, chief engineer, Ohio State Department of Health; in his paper he outlined the Ohio situation, where growing cities are being forced to abandon ground water for surface waters. Exploration by test wells for low hardness water when seeking ground supplies was insisted upon by the board of health on PWA projects, since a saving in softening cost of one cent per 1,000 gal. is possible with a reduction of 1 p.p.m. of hardness. Where disposal of sludge from the softening process is difficult, some cities are using incinerators to calcine the lime, which is then reused; the surplus lime is sold.

H. H. Gerstein, Water Purification Division, Chicago, reviewed safe methods of handling chlorine and ammonia as used in the twelve Chicago plants. Since few doctors have had experience with gassing by chlorine or ammonia, full reports of how to treat these cases as set up by various chemical companies, the Interstate Commerce Commission, and the more recent AWWA report on the subject should be put into the hands of the plant physician.

Unusual design features of the 200-m.g.d. Milwaukee filtration plant were described by Herbert H. Brown, design engineer.

Water for resettlement projects

Elmer Becker, Milwaukee Water Department, formerly with the Resettlement Administration, discussed the water systems for Greendale, Wis., and other federal suburban developments. A well supply is being built at an estimated cost of $276,000 or 22.1c. per 1,000 gal. Two 1,800-ft. wells furnished 2,000 g.p.m. Greenhills, near Cincinnati, has a well system, the Cincinnati charges being considered too high. Greenbrook, N. J., now abandoned, was to obtain its supply from a water company. Greenbelt, near Washington, will buy water from the Washington Suburban Water District, which obtains its supply from the Burnt Mills plant treating Anacostia River water.

Officers elected for the ensuing year are as follows: Chairman, Clarence Greutzmacher, and secretary-treasurer, L. A. Smith, Madison.

Soil Studies Featured At Highway Research Meeting

The sixteenth annual meeting of the Highway Research Board will be held in Washington, D. C., during the week of Nov. 16. Tuesday and Wednesday, Nov. 17 and 18, will be devoted to open meetings of the various departments of the board for informal discussion of current highway problems. The regular annual board meeting will be held on Thursday and Friday, Nov. 19 and 20.

Soil studies

Special emphasis is being placed in the program on the important rôle of soils in roadwork. An informal open meeting of the soils investigation department will be held all day Tuesday. A symposium on stabilized soils for roads will be held on Friday afternoon, and several important committee reports will be devoted to the subject.

Roadside development

Another topic receiving attention is that of roadside development. In addition to several reports at the annual meeting, the departments of design and maintenance will join with the joint committee on roadside development of the board and the American Association of State Highway Officials in an open meeting on Wednesday afternoon for the informal discussion of roadside problems.

Open meetings will also be held on Wednesday by the departments of highway transportation economics, materials, and construction.

One session of the annual meeting will be devoted to problems in highway traffic with particular reference to safety measures.

Bridge Near Buffalo Wrecked by Truck

A 150-ft. through truss bridge over Cattaraugus Creek on the Ashford-Springville Road near Buffalo, N. Y., collapsed on Oct. 5 when a heavy truck loaded with scrap metal struck one of the trusses.

The truck got out of control on a downhill curve leading to the bridge. It went through the bridge, killing the driver and injuring a boy riding with the driver.

A similar accident to a bridge in Virginia was reported in *ENR*, Sept. 10, 1936, p. 388.

SOCIETY CALENDAR

NATIONAL COUNCIL OF STATE BOARDS OF ENGINEERING EXAMINERS, annual meeting, Knoxville, Tenn., Oct. 19-21.

AMERICAN WELDING SOCIETY, annual meeting, Cleveland, Ohio, Oct. 19-23.

AMERICAN PUBLIC HEALTH ASSOCIATION, annual meeting, New Orleans, La., Oct. 20-23.

AMERICAN RAILWAY BRIDGE & BUILDING ASSOCIATION, annual meeting, Chicago, Ill., October 20-22.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, annual convention, White Sulphur Springs, W. Va., Oct. 21-23.

ASSOCIATED GENERAL CONTRACTORS, fall meeting of governing board, Washington, D. C., November 16-17.

HIGHWAY RESEARCH BOARD of the NATIONAL RESEARCH COUNCIL, annual meeting, Washington, D. C., Nov. 18-20.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual meeting, San Francisco, Calif., December 7-10.

AMERICAN WATER WORKS ASSOCIATION, NEW YORK SECTION, fall meeting, Saratoga Springs, N. Y., October 15-16.

STRUCTURAL ENGINEERS ASSOCIATION OF CALIFORNIA, annual convention, Santa Maria, Calif., October 16-18.

AMERICAN WATER WORKS ASSOCIATION, NEW JERSEY SECTION; NEW JERSEY WATER WORKS ASSOCIATION; and the SOUTH JERSEY ASSOCIATION OF WATER SUPERINTENDENTS; joint meeting, Atlantic City, N. J., Oct. 23-24.

AMERICAN WATER WORKS ASSOCIATION, MISSOURI VALLEY SECTION, Kansas City, Mo., October 26-28.

AMERICAN WATER WORKS ASSOCIATION, NORTH CAROLINA SECTION, and NORTH CAROLINA SEWAGE WORKS ASSOCIATION, joint meeting, Charlotte, N. C., Oct. 26-28.

CENTRAL STATES SEWAGE WORKS ASSOCIATION, annual meeting, Indianapolis, Ind. Oct. 29-30.

AMERICAN WATER WORKS ASSOCIATION, VIRGINIA SECTION, and VIRGINIA SEWAGE ASSOCIATION, joint meeting, Charlotteville, Va., Oct. 29-30.

LICENSE EXAMINATIONS

NEW YORK STATE, examination for professional engineers and surveyors, Jan. 25-27, at Albany, Buffalo, New York City and Syracuse. Applications must be filed with the State Education Department at Albany before Nov. 1.

At a meeting held in Chattanooga, Tenn., on Oct. 9 the TENNESSEE VALLEY SECTION of the AMERICAN SOCIETY OF CIVIL ENGINEERS elected the following officers: President, E. D. Burchard, Asheville, N. C.; vice-presidents, R. L. Maynard, Asheville, N. C., Henry Fruend, Knoxville, Tenn., Gerald Kavanagh, Chattanooga, Tenn., Robert Olds, Pickwick Landing; secretary-treasurer, Hal Hale, Knoxville, Tenn.

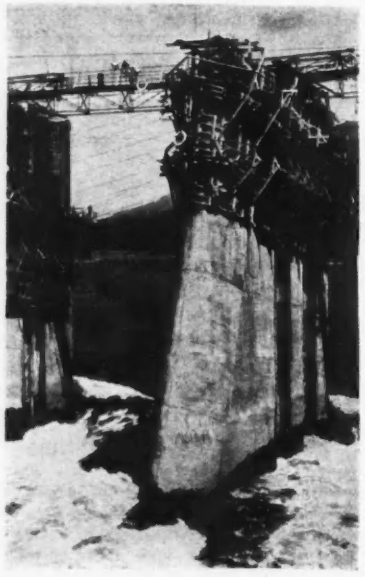
Brief News

A COMMITTEE OF ENGINEERS and soil conservationists from the Department of Agriculture is about to begin a survey of the Everglades in Florida, looking toward the development of a regional plan for development and conservation of the 4,500,000 acre area.

REBUILDING AND ENLARGING the major part of Charity Hospital at New Orleans, La., will be an $8,000,000 project; $3,600,000 has been provided by a PWA grant. The plans provide for razing 12 old buildings and substituting one large 19-story structure. Architects on the project are Weiss, Dreyfous and Seiferth.

THE HIGHEST ROAD IN EUROPE was opened in mid-September. It is the Italian Route Nationale 202, the road over the Iseran Pass, from Val D'Isere to Bonneval Sur Arc in Savoy. The top of the pass has an altitude of 9,088 ft. and is reached by some sharp hairpin bends. The new road, which has a width of 26 ft., forms part of the famous Route des Alpes, now under construction. It will not be formally opened until 1937.

THE ONTARIO HYDRO POWER Commission plans a 10,000 hp. water power development at Ragged Rapids on the Muskosh River to increase the power supply of the Georgian Bay system. It is planned eventually to develop three power sites on the Muskosh River with a total capacity of 45,000 hp.; the Ragged Rapids project is the first to be developed. It is expected the work will take about 18 months, and construction will start as soon as government approval is obtained.



COMPLETING THE PIERS AT BONNEVILLE DAM

The piers of the Oregon end of Bonneville Dam, now under construction with an initial PWA allotment of $32,440,700, are being carried up to full height while the river is diverted through the openings between. When work in the north cofferdam is completed concrete between these piers will be brought up to spillway level.

THE NEW YORK STATE Board of Examiners of professional engineers and land surveyors granted 2,571 licenses during the year ending June 30, 1936. The board considered 4,424 applications for licenses, more than twice the number considered in the previous year. Of this number, 1,421 received licenses without examination and 1,443 candidates took a written examination, of whom 1,155 received licenses. More than twice as many applicants took the examination this year as last, and the percentage of those passing the examination was 80 per cent this year as compared with the 76 per cent who passed the examination in the preceding year.

AS A STEP IN THE BUILDING of a $5,800,000 industrial water system for Birmingham, Ala., the city commission on Sept. 8 awarded a contract to the Walsh Construction Co. of Davenport, Iowa, for an impounding dam on the Black Warrior River about 40 miles from the city. The contract calls for a rock-fill dam to cost $1,685,231. Bids were also received for concrete dams, but they ran considerably higher. The dam will be 185 ft. high and 1,500 ft. long. Water will be brought into the city through a 60 in. main and distributed to a group of industrial plants which the city's regular water system has been unable to supply. Contract for the 60-in. steel pipe was awarded jointly to the Chicago Bridge & Iron Co. and the Ingalls Iron Works on a bid of $11.44 a foot. The project is being financed by the Public Works Administration.

Personals

CAPT. H. KRAMER, Corps of Engineers, has been appointed district engineer at Conchas Dam, N. M.

CHARLES D. SUTHERLAND has been appointed chief architect of the department of public works of Canada.

STANLEY H. WRIGHT has been appointed acting state director of public works of North Carolina.

J. G. BRAINARD, formerly assistant engineer in the power division of the PWA, has been appointed assistant PWA engineer for the state of Nebraska.

WILLIAM KNARR, resident engineer for the Kentucky state highway department in Christian County, has been appointed assistant district engineer for the first highway district.

LIEUT. COL. D. O. ELLIOTT, Corps of Engineers, who has been assistant to the division engineer in the Ohio River Division, has been appointed district engineer of the Cincinnati, Ohio, district.

R. C. CHANEY, formerly chief resident engineer inspector of the PWA nonfederal service in the Cleveland area, has been appointed state engineer inspector of PWA for Ohio.

EDWARD FAIRBAIRN has been named county engineer of Sacramento County, Calif. Mr. Fairbairn was in charge of the county engineer's office during the illness of the late John J. Rooney.

WILLIAM BOWIE, chief of the division of geodesy of the U. S. Coast and Geodetic Survey, was awarded the degree of doctor of laws by the University of Edinburgh on Sept. 17.

LYLE MCBRIDE, resident engineer of the Ohio state highway department for Ashtabula County, has been appointed assistant division engineer in charge of maintenance for Division No. 4.

R. R. ZIPPRODT, who has been a regional structural engineer for the Portland Cement Association in New England, New York, and New Jersey, has been appointed associate professor of civil engineering at Columbia University.

EDWARD P. MCCLELLAN, junior engineer in the office of the United State District Engineer at Charleston, S. C., has been promoted to assistant engineer in the office of

the United States Engineers at Manila, P. I. Mr. McClellan has been in the United States Engineer service since 1928.

JOHN C. GUIBERT has been appointed county engineer of Nassau County, New York.

Obituary

JOHN W. DAVIS, 70, a building contractor of Newport News, Va., died there on Oct. 5.

OLIVER U. COSTICH, a sewer and road contractor of Rochester, N. Y., died there on Oct. 8 at the age of 49.

JOSEPH L. RUSLING, a retired consulting engineer and at one time chief engineer in charge of construction of the New York, Susquehanna and Western Railroad, died on Oct. 7 in Glen Rock, N. J., at the age of 89.

HENRY N. CHASE, a retired construction engineer, died at Hyannis, Mass., on Oct. 4, at the age of 62. After his graduation from Dartmouth College in 1895 he engaged in railroad building in the West. Later he was in charge of various government projects in Boston harbor for 10 years, later becoming senior engineer on reclamation work on the Illinois River and having charge of improvements at Plymouth Harbor, Mass.

HERBERT H. MCCORD, vice president, secretary, and a director of Post & McCord, building contractors of New York City, died in Greenwich, Conn., on Oct. 7 at the age of 56. Mr. McCord's duties were concerned with the business side of the steel erection department of the firm. He was actively concerned in the steel work on many buildings in New York City, including the Empire State building and Rockefeller Center.

CONSTRUCTION STATISTICS FOR THE WEEK

ENGINEERING awards of $26,769,000 are reported for the past week, which includes the Columbus Day holiday. Of this amount private work is $10,664,000; public, $16,105,000; federal, $3,077,000; state and municipal, $13,028,000. Corresponding values for a year ago are: total, $21,972,000; private, $4,580,000; public, $17,392,000; federal, $3,307,000; state and municipal, $14,085,000.

Bridge awards are high for the short week, totalling $3,454,000. Other classifications include: public buildings, $2,538,000; commercial buildings, $3,883,000; industrial buildings, $4,054,000; highways, $7,902,000; sewerage, $529,000; waterworks, $327,000; earthwork, drainage, $1,650,000; unclassified, $2,432,000.

The larger projects for the week include: factory, W. S. Merrill Co., Cincinnati, Ohio, $800,000; addition to Vanderbilt University Hospital, Nashville, Tenn., est. $1,000,000; male and female ward buildings, Dixon State Hospital, Dixon, Ill., $795,000; highways, by Oregon, $891,000; by Pennsylvania, $685,000; by Connecticut, $711,000; by New York, $1,020,000 and $1,291,000; grade crossing elimination over seven railroads, Tifft Street Bridge, Buffalo, N. Y., $953,000; grade crossing elimination, Belleville Turnpike, Erie Railroad, State Highway Department, New Jersey, $517,000; covering tracks part West Side Highway, from 98th Street to 111th Street, New York Central Railroad, New York, $500,000; completing twin locks at Lock and Dam 26, Mississippi River, Alton, Ill., $1,160,000; 27,000 tons steel rail and track fastenings, Louisville and Nashville Railroad, Louisville, Ky., $1,250,000.

New capital for the week includes PWA allotments $11,129,000, state and municipal bond sales $15,398,000 and corporate security issues, $350,000.

CONTRACTS

(Thousands of Dollars)

	Weekly Average Oct. 1935	Prev. 4 Weeks	Week Oct. 15 1936
Federal Government	$6,563	$5,574	$3,077
State and Municipal	17,907	25,560	13,028
Total public	$24,470	$31,134	$16,105
Total private	12,056	26,323	10,664
Week's total	$36,526	$57,457	$26,769
Cumulative to date:			
1935	$1,112,363,000	1936	$1,869,832,000

NEW PRODUCTIVE CAPITAL

(Thousands of Dollars)

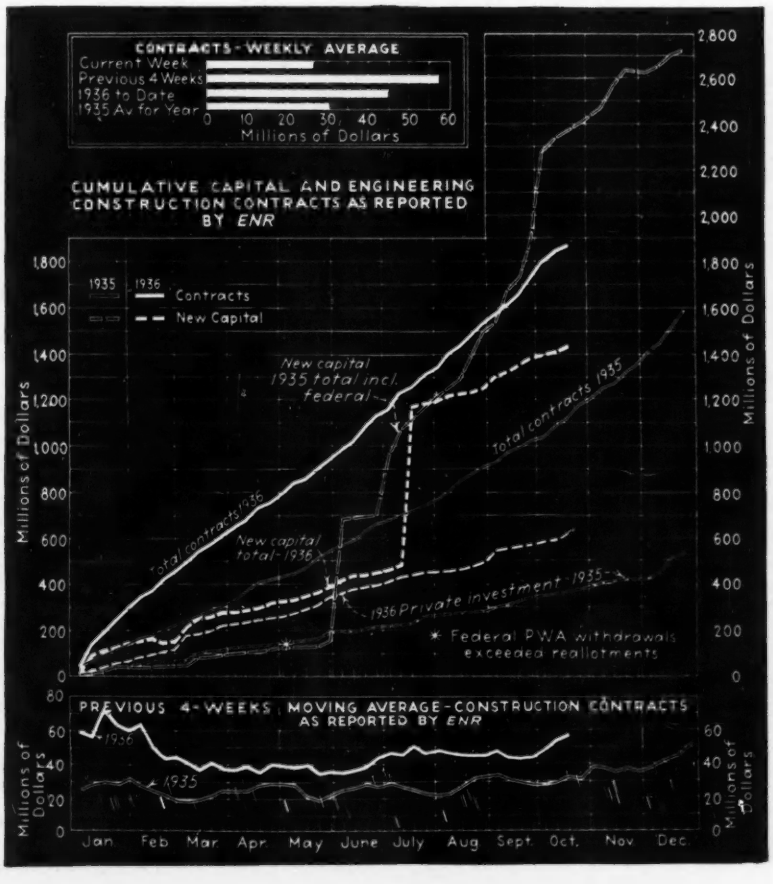
1936	Week Oct. 15	Cumulative
State and municipal	$15,398	$407,431
PWA non-federal	11,129	102,213
RFC loans	....	26,663
Corporate issues	350	204,359
PWA loans, Private	....	—1,665*
Total Non-Federal	$26,877	$739,001
Federal	....	691,237
Total new capital	$26,877	$1,430,238
Cumulative to date:		
1935	$2,361,053,000	1936	$1,430,238,000

*Bond sales in this classification exceed reallotments during current year.

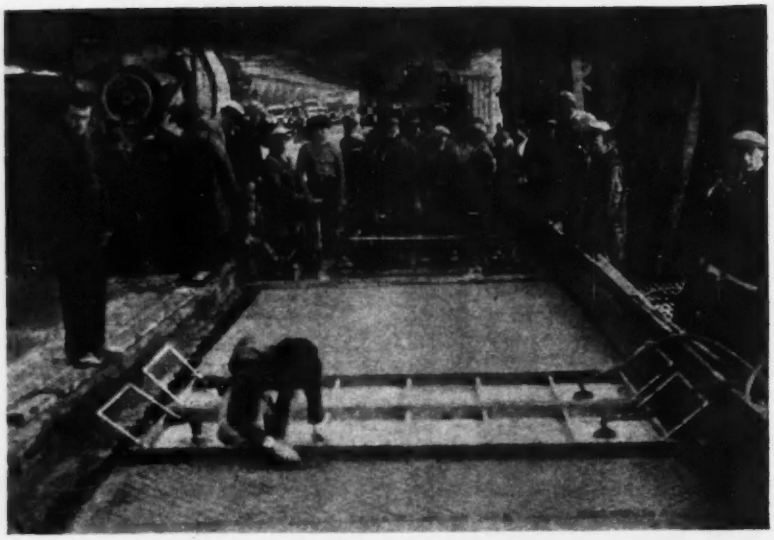
Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities. RFC direct purchase of bonds for "self liquidating" projects, and 25 per cent of WPA construction appropriations.

INDEX NUMBER

ENR	1913 = 100	1926 = 100	ENR	1913 = 100	1926 = 100
Cost			Volume		
Oct., 1936	211.50	101.67	Sept., 1936	200	88
Sept., 1936	208.10	100.08	Aug., 1936	199	87
Oct., 1935	195.10	93.82	Sept., 1935	140	61
1935 (Av.)	195.22	93.84	1935 (Av.)	135	58
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50
1933 (Av.)	170.18	81.80	1933 (Av.)	104	27


CONTRACTS - WEEKLY AVERAGE
Current Week
Previous 4 Weeks
1936 to Date
1935 Av for Year
0 10 20 30 40 50 60
Millions of Dollars
CUMULATIVE CAPITAL AND ENGINEERING CONSTRUCTION CONTRACTS AS REPORTED BY ENR
1935 1936
Contracts
New Capital
New capital 1935 total incl federal
Total contracts 1935
Total contracts 1936
New capital total-1936
1936 Private investment-1935
* Federal PWA withdrawals exceeded reallotments
Millions of Dollars
PREVIOUS 4-WEEKS MOVING AVERAGE-CONSTRUCTION CONTRACTS AS REPORTED BY ENR
1936
1935
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec

Construction Equipment and Materials



Vacuum Concrete Tried on Queensboro Bridge

The new vacuum compression method of finishing concrete surfaces (*ENR*, Dec. 19, 1935, p. 867) was given a trial Sept. 29 on the Queensboro bridge in New York City. The bridge is being repaved with a 7½-in. concrete slab, and the vacuum process was applied to a section about 50-ft. long of one 10-ft. lane. In the attached view, two of the three 3x10 ft. units are shown in place, with the vacuum lines attached. The concrete in the foreground has had its excess water sucked out and has been compressed by the atmospheric pressure acting on top of the unit until it is hard enough to walk on; a non-skid surface results from wires placed on the bottom of the unit. The units are left attached for about 20 min. In the background the slab has been struck off.

The vacuum units are made up of a bottom layer of cotton mesh separated from the metal frame on the top by corrugated metal sheets; the corrugations of these sheets permit suction to act over all parts of the concrete surfaces. The process is being developed by the Vacuum Concrete Corp., 30 Rockefeller Plaza, New York City.

New Equipment in Brief

Asphalt heater—The White Mfg. Co., of Elkhart, Ind., announces a heater for warming natural rock asphalt before it is placed on roads. The heater consists of an all steel box mounted on wheels or skids. The asphalt is placed on a screen at the top of the box and, as it becomes warm and dry, drops through the screen into a lower compartment. A large hinged door permits the warm material to be shoveled out. Heat is furnished by a White self-generating burner held on a bracket at one end.

Coating—Coppercote, developed by the American Coppercote Co. of New York City, is pure metallic copper of extreme fineness and of an irregular flaky structure suspended in liquid. When applied to iron, steel, wood, or concrete surfaces, it forms a protective coating which is said to offer complete protection against corrosion, electrolysis, or termite action.

Jackhammer—The new JA-45 jackhammer developed by the Ingersoll-Rand Co. of New York City incorporates a newly designed valve that is said to reduce air consumption by a third.

Snow plow—A new V-type snow plow developed by J. D. Adams Co. of Indianapolis, Ind., for use in connection with Adams graders, is said to be the largest plow ever built for use on a motor grader. The plow has a cutting width of 9 ft. across the nose and 12 ft. across the widest part of the V. The 5-ft. height from the ground to the center of the moldboard curve at the rear is said to enable the plow to go through heavy snow that would cover up a smaller plow. It may be raised 14 in. off the ground.

Fire-resistant canvas—A fire resistant cotton duck convas fabric has been developed by William E. Hooper & Sons of Philadelphia. The company furnishes either a treated fabric, known as Fire Chief, or a separate finish, known as Hooperwood Fire Chief Compound, which can be applied to any type of cotton duck. Fire Chief compound is said to waterproof the canvas as well as make it fire-resistant.

Noel Welders

Unusually high efficiencies are claimed for the Noel Speedarc welder recently developed by the Ideal Electric & Mfg. Co. of Mansfield, Ohio. It is said that the overall efficiency of the 300 amp. welder is from 58 to 68 per cent. Economy is said to be given also by the fact that the machine is designed so that it possesses a unity power factor at full load.

The manufacturers claim to have eliminated the necessity for re-striking the arc and the possibility of sticking of the electrode to the work at the time of striking the arc by designing the machine with a very low short circuit current and a very rapid recovery from short circuit current to normal welding current. This is made possible by the fact that, in this design, changes in voltage do not require a change in magnetic flux in the main field coils. Voltage regulation is provided by an auxiliary field coil setting up a back electromotive force proportional to the current.

The machine is of welded steel construction throughout and is entirely enclosed.

Recent Publications

Blue Streak Sewage Gas Engines, published by the **Climax Engineering Co.**, of Chicago, tells how Blue Streak engines operate on sewage gas at the Aurora, Ill., sewage disposal plant. • **The Atlas Powder Co.** of Wilmington, Del. has just issued its new catalog, *Atlas Explosives*. • A handy slide rule for computing time cycles and hourly yardage deliveries in moving dirt with scrapers over varying grades and distances is furnished by the **R. G. LeTourneau Co.** of Peoria, Ill. • *Special Attachments* for Caterpillar tractors to meet the needs of varying jobs are described in a 47-page booklet issued by the **Caterpillar Tractor Co.**

• *Belting, Hose, Packing*, a catalog issued by the **New York Rubber Corp.**, covers, among other things, conveying belts and dredging sleeves and hose. • *Standard Instruments*, the catalog of **Julien P. Friez & Son**, of Baltimore, Md., describes their complete line of weather recording instruments. • • Four new leaflets of the **General Electric Co.** of Schenectady describe as many types of their new line of induction motors, the general purpose squirrel-cage, the splash-proof, the explosion-proof and the totally enclosed fan-cooled. • *Folder No. 1591*, recently released by **Link-Belt Co. of Philadelphia**, gives rather detailed information on the construction and application of the G&M tunnel shield for constructing concrete lined tunnels of 4 to 8 ft. diameter. • The **United States Gypsum Co.** of Chicago believes that their booklet *Lime*, is the first comprehensive summary of the manufacture, uses, and type of lime used in construction and industry.

• Four new pamphlets, *P3-49, 50, 51*, and *57*, of the **Wellman Engineering Co.** of Cleveland, describe their single and multiple-line handling and excavating buckets. • A new catalog of *Industrial Products* may be had from the **Johns-Manville Co.** of New York City. • An attractive booklet containing some striking illustrations describes *Boulder Dam*. It may be had from the **Barrett Co.** with offices in New York City.